POST-OPERATIVE PAIN FOLLOWING HYSTERECTOMY IN RELATION TO MUSCLE TENSION, PSYCHOLOGICAL FACTORS AND MORPHINE USE.

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ERRATA

Page		Line	
-	Abstract	14	disturbance --- discomfort
6		last line	disturbance --- discomfort
27	II.2.6		insert, "Patients with..." at start of paragraph
42		3	waid --- said
60a		17	disturbance --- discomfort
65		19	sight --- site
88		5	optional --- optimal
90		5	should read, "and Function 2 separated the middle group from the other two."
105		31	design --- decision
121		2	omit second word, "is".

"It is by poultices, not by words, that pain is ended, although pain is by words both eased and diminished".

Petrarch, 14th century.

"Pain is not a simple affair of an impulse travelling at a fixed rate along a nerve. It is the resultant of a conflict between a stimulus and the whole individual".

Leriche, surgeon, late 19th century.

"There is no simple direct relationship between the wound per se and the pain experienced".

Beecher, 1966.

ABSTRACT

The efficiency of relaxation training in ameliorating post-operative pain after a hysterectomy was examined. Psychological tests of anxiety, depression and illness behaviour were administered. Electromoygraphic measurements of the forehead muscles and the rectus abdominis muscle were taken simultaneously pre-operatively and for three days after the operation. Half of the experimental group of 49 subjects received analogue auditory feedback of the activity of these muscles. The abdominal muscle showed normal relaxed behaviour and the activity in the forehead region reflected trait anxiety. Pain words used to communicate suffering were analysed to identify specific dimensions of the post-operative pain and the major factor which accounted for 20% of the variance referred almost entirely to emotional disturbance. The 24 control subjects were given more morphine than the experimental subjects. Age was an important consideration as younger patients appeared to be more vulnerable. The irritability dimension of illness behaviour correlated significantly with predictor and outcome variables. It was concluded, therefore, that patients in the experimental groups benefited from the relaxation sessions because anxiety and irritability were decreased, resulting in a lower requirement for morphine. The auditory feedback was not essential for these changes to occur but other aspects of the EMG biofeedback procedure may have reinforced relaxation behaviour.

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I.1. GENERAL INTRODUCTION

THE NATURE OF PAIN

Throughout the centuries the words "pain" and "pleasure" have always been associated. e.g.

> "There is a certain pleasure that is akin to pain".
>
> Metrodurus, 4th Century
>
> "Their pleasures here are past, so is their pain".
>
> Shakespeare, in
> Cymbeline, 16th Century
>
> "Every pleasure hath a payne they say".
>
> Chapman, 16th Century
>
> "Sweet is pleasure after pain".
>
> Dryden, 17th Century

Such an association suggested that pain is an emotion.

Philosophers also had ideas on the nature of pain: Buytendijk (1943) saw the notion of 'reaction to pain' as containing 'the germ of the entire problem of pain'. He saw that a totally different conception of man from that yielded by a neurophysiology based on Cartesian principles or clinically derived theory, was required. He said in considering the dual aspect of pain that the reaction pattern often seemed to be independent of the awareness of pain.

Michaux (1957) emphasised the influences of human relationships on pain, and saw the word 'pain' as representing "the coded language of moral pain and emptiness".

Sartre (Fells, 1965) separated pain from emotion by saying that an emotion required an evaluation, and that this in part, distinguished an emotional reaction from a pain or a proprioception. He saw a pain as preceding evaluation, although it may subsequently be evaluated, and it may become an object of emotion. But, he said, emotion was necessarily consequent upon evaluation, and thus, emotion signified in a way which pain did not.

Three levels of pain were separated by Szas, (1968). 1) There is a biological level of pain - the concept of pain is that of a signal by which the perceptive part of the organism registers that there is a threat to its structural and functional integrity: in this concept of pain there is only one person involved. 2) The expression of pain is a fundamental method of asking for help. Two or more people are involved in this situation. 3) The meaning of the word 'pain' lies largely in its communicative aspect. Pain, in this context, may no longer denote a reference to the body. Pain may then function as an affect, warning the ego of the danger of the loss of an object.

Wolff and Wolf(1951) gave an interesting summary of the situation by saying that until the end of the nineteenth century, pain was considered to be exclusively a feeling state. Later, with the discovery of special anatomic equipment and mechanisms, interest was focussed on the perceptual aspects of pain. They said that pain, to be sure, was a sensation, and yet because of its intimate linkage with strong feelings and other reaction patterns, the latter may be dominant in experience. It was known that reactions to pain may be modified by strong beliefs, and that although analgesics actually raise the pain threshold, they also have a major function in changing the attitude and feelings of the patient. The authors supported the old conviction that the feeling state (emotion) was, to the one who suffered, perhaps the most relevant aspect of pain, but they supported as well the inference that pain was a specific sensation with its own structural and functional properties. Thus, they propounded two concepts which did not oppose each other as both formulated fundamental aspects of the pain experience.

A final philosophical approach is that in which Baier (Trigg, 1970) tied the word 'pain' to pain behaviours. He said that a person was taught the concept of pain and that whatever a person felt on those occasions when he naturally manifested pain he would learn to call pain. Since the child learnt the word pain on occasions when he felt something that he wanted to stop or reduce in intensity, or the return of which he was afraid, the meaning of the word, 'pain' would be,'something which I dislike'. Because pain was almost universally disliked and because this fact was depended upon in order to teach the concept, the word 'pain' can be used to refer to the whole experience of sensation and emotion. The ability to teach the concept of pain was completely dependent on that behaviour which was the expression of emotional reaction to pain.

Melzack(1973) who developed the 'Gate Control Theory of Pain' also said that to consider pain as a sensation was a relatively recent occurrence and that the older theory, dating back to Aristotle, considered pain to be an emotion - the opposite of pleasure - rather than a sensation. Melzack, like Baier, noted that pain was not just a sensory quality, but also had a strong negative affective quality that drove a person into activity. He went on to say that the remarkable development of sensory physiology and psychophysics during the 20th century had given momentum to the concept of pain as a sensation and had overshadowed the role of affective and motivotional processes. Melzack considered that the sensory approach to pain, however valuable it had been, failed to provide a complete picture of pain processes... the assumption that pain was a primary sensation had relegated motivational and cognitive processes to the role of 'reaction to pain' and had made them only 'secondary considerations' to the whole pain process. He concluded that sensory, motivational and cognitive processes occurred concurrently in parallel, interacting systems and that motivational/affective processes must be included in any satisfactory theory of pain.

The medical approach to the treatment of pain is still mainly concerned with the sensory model of pain. Some recent research examined chronic pain and affect; this research aimed to examine acute pain in relation to emotion,and the possibility of ameliorating that pain by training a subject to relax.

I.2 SUMMARY OF INVESTIGATION

An examination was made of muscle tension and its correlates in relation to post-operative pain. It was hypothesized that electromyographic (EMG) recordings would show different activity in a muscle adjacent to the wound (rectus abdominis muscle) and away from the wound (forehead muscles), with the former being related to pain as sensation and the latter to pain as anxiety. It was hypothesized also that patients showing less EMG activity would experience less pain as measured by morphine intake. The effectiveness of biofeedback as a technique for inducing muscle relaxation was observed.

The nature of pain experienced by women having hysterectomies was ascertained by factor analysing pain descriptors, and from this an "emotional disturbance" factor of pain was identified and calculated and used as a further dependent variable.

The scales of the abnormal illness behaviour questionniare were analysed in relation to the independent and dependent variables in a search for common elements between pain, emotion and behaviour.

II LITERATURE REVIEW

II.1 MEANING OF PAIN

Pain definitions varied, like the phenomena itself. Merskey (1964) described pain as an unpleasant experience primarily associated with tissue damage, or described in terms of tissue damage, or both; to Sternbach (1968), pain was an abstract concept which referred to a personal, private sensation of hurt; a harmful stimulus which signalled current or impending damage; a pattern of responses which operated to protect the organism from harm. Both those definitions indicated the subjective nature of the pain experience. The obvious biological significance of pain leading to the expectation that it must always occur after injury and to the conclusion that the intensity of pain felt must be proportional to the amount and extent of the tissue damage was discussed by Frazier (1974) who concluded by quoting a study by Beecher (1966) which he considered to be a "classical" pain perception study made during World War II. Beecher demonstrated that there was no simple direct relationship between the wound per se and the pain experienced; the pain was in very large part determined by other factors and of great importance here was the significance of the wound - that is, the reaction to the wound. Melzack (1973) said that the unique, distinctly unpleasant affective quality of pain differentiated it from other sensory experiences; that it became overwhelming and disrupted ongoing behaviour and thought and motivated the organism to stop its unpleasantness as quickly as possible; that pain experience was greatly influenced by expectations, suggestion and level of anxiety and that recognition of these variables was important in devising therapies based on the cognitive control of pain.

Pilowsky (1978) saw in the word 'pain' intrapsychic, interpersonal and societal significance of a sort possessed by few other descriptors of personal experience; the meaning of this word for an individual depended on the same factors which determined his entire personality; he saw psychological, emotional and somatic variables as combining to produce pain. Pain can also be viewed as learnt behaviour, and Fordyce used this model related in particular to chronic pain; he looked at reinforcers for pain behaviour and considered that the diagnostic process should examine the relationships between pain behaviour and both pathogenic factors and systematic environmental consequences; i.e. what part does learning play in pain behaviour in a specific circumstance? An extension of Fordyce's approach would look at the reinforcers for pain behaviour after surgery, such as care, security and attention. The difficulties of considering pain as a sensory modality were looked at by Hilgard (1969). Most defined sensory modalities have definite stimuli, definite receptors, specific sensory tracts and localised, receptor areas in the brain - but not pain. Any stimulus could qualify to produce pain if it were intense enough. The receptors were unspecified despite the role traditionally assigned to free nerve endings. While there were pathways for cutaneous pain there were at least two afferent systems and they operated quite differently. (Melzack and Wall, 1965.) In considering physiological correlates of pain, no single accepted indicator of pain at present could be identified that varied in an orderly way with degrees of pain and absence of pain. Finally, Hilgard considered pain as informative, but noted the exceptions that did not give information of the locality of pain; i.e. referred pain, although this could be interpreted by trained persons; psychosomatic or psychogenic pain; and phantom limb pain in which the pain is extracorporeal. Liebeskind (1977) examined the psychological and physiological mechanisms of pain and logically concluded that pain inhibition may only occur in three ways: locally (passively) by blockage of critical portions of the pain pathway peripherally or centrally; centripetally (actively) by interactions among first-order sensory nerve fibres or among central neurones in their afferent pathway; or centrafugally (actively) via descending fibres from higher control structures to lower ones. He considered that the centrafugal systems may underly analgesic procedures which depended upon expectation, suggestion, hypnosis, and possibly helplessness. The enormous intersubject variability in degree of analgesia obtainable by these procedures attested to the difficulties most organisms have in reliably assessing their own centrafugal pain - inhibitory systems. In humans, cognitive capacities to think, to believe and to hope probably enabled them, under appropriate conditions, to find and deploy pain-inhibitory resources. Liebeskind concluded that behavioural psychologists needed to explore the techniques that could enable people to make use of pain-inhibitory responses when needed.

Such behavioural studies are now being conducted relating to chemical mechanisms in pain modulation. Goldstein (1971) demonstrated the existence of opiate receptors in biological tissue. Since it was unlikely that such highly specific receptors would have evolved to interact with exogenous opiates (morphine) a search was made for endogenous opiates, first identified by Terenius and Wahlstrom (1975) and Hughes (1975). Snyder (1979) looked at the relationship of enkephalins and opiate receptor pathways and found that not only did the enkephalins operate within the nerve tracts that signalled chronic pain to the brain, but that they and their receptors were also strategically placed along those nerve pathways with the brain dominated by monoamine neuro-transmitters. Positioned to control the transmission of signals along the primary pathways of perception, emotion and pain, the enkephalins appeared situated to play a prominent role in modulating sensory sensations and many emotional reactions. Pert (1979) said that the presence of enkephalinergic terminals and opiate receptors in central nervous system regions that are involved in processing pain information suggested that the brain contained an endogenous pain-suppresion mechanism which may be activated by certain environmental conditions or endogenous factors.

Wahlstrom (1978) has shown that enkephalin terminals are located along known pain pathways in the nervous system, and also in the limbic system, and this could be where the emotional aspects of pain may reside. Amir (1978) aimed to show that immobilization stress produced pronounced naloxine-reversable alterations (naloxine is the antagonist of opiates) in escape from a noxious thermal stimulus (hot-plate) but failed to alter the paw-lick response to the same stimulus in rats. The conclusion was that the analgesic effect of endorphines in the rat hot-plate test was greater on the escape response than on the paw-lick response and that the "hyper-analgesic" effect of naloxine following the same distinct pattern was consistent with the notion that endorphines may modulate the affective reaction to pain rather than the perception of or reaction to pain. Jacob (1978) in a similar experiment using mice on the hot-plate test after restraining also concluded that endorphines modulated the response to, but not perception of, nocioceptive stimuli. Thus, behavioural and neurophysiological research substantiates theories of pain that purported that both emotion and sensation were necessarily inherent in the meaning of the word 'pain'.

II.2 PSYCHOLOGICAL VARIABLES

II.2.1 ANXIETY

Beecher (1966) noted the presence of "true anxiety" as being of great importance in pain. Haslam (1966) demonstrated that anxiety lowered the pain threshold by introducing anxiety into the laboratory study of pain. He showed experimentally that the mean heat-pain threshold for a group of subjects threatened with electric shock was lower than for a group not threatened. That a person's reactive pain was greater when his/her anxiety about that pain was high was shown by Bowers (1968) when he demonstrated that levels of shock perceived as painful varied as a function of instructions conveying differential perception of control over shock. Also in the laboratory, Lepanto (1965) showed that when a person had control of a situation, pain was more easily tolerated, and that an increase in anxiety led to lower pain thresholds. Caldwell (1977), noted that fear was notoriously resistant to extinction and that fear arousal reduced the pain threshold, so that increasing fear intensified the experience of pain. He looked at the need clinically to reduce "pain-fear".

Spielberger (1966) and Lazarus have distinguished between acute or situational anxiety and anxiety proneness or predisposition. Trait or anxiety proneness was a relatively unfluctuating condition of the individual which exerted a constant influence on his behaviour. Such a condition was usually regarded as a personality trait. Situational anxiety was a transitional state which was ephemeral, occured in response to a stimulus, and was characterised by a variety of physiological reactions associated with adreno-sympathetic arousal. Spielberger (1973) studied the relationship of state anxiety (as measured on STAI-X1, A-state) and trait anxiety (as measured on STAI-X2, A-trait) to surgery. He defined state anxiety as a transitory emotional state and trait anxiety as a relatively stable personality trait. He reported higher levels of A-state prior to surgery compared with a post-surgery convalescent period as being consistent with other workers. i.e. the threat of imminent surgery led to pre-operative elevations in A-state. Persons high in A-trait did not regard surgery as any more dangerous and threatening than low A-trait individuals. Trait anxiety did not change when measured pre-surgically and post-operatively, but state anxiety reactions to surgery appeared to be most intense for patients who scored high in trait anxiety. Thus, the threat of imminent surgery produced elevations in anxiety as an emotional state but did not affect anxiety proneness (trait). In an earlier study with Johnson (1968) Spielberger showed that A-state measures declined significantly in response to relaxation training procedures. A-trait measures were impervious to such variations in stimulus conditions.

This relationship between anxiety and surgical pain has been studied over many years. In 1958, Corman studied pre- and post operative fear and found no positive correlation between pre-operative psychological assessment and the incidence of post-operative behavioural disorders and post-operative reactions, which,when they occurred ,could often be understood in terms of the dynamic life history of the patients (80% pre-operatively and 40% post-operatively). Fear played an important role in increasing the complaint of pain. Egbert (1964) reported that when surgical patients were informed of the nature of post-operative pain that they might experience and were instructed in methods of coping with this pain that they required less narcotic medication after operations than subjects not so informed and instructed, and he presumed this was because of reduced anxiety.

In 1971, Johnson and Levanthal showed that a linear relationship of pre-operative fear and outcome existed. They studied patients having hysterectomies and cholecystectomies, using the MAS to measure trait-anxiety, the pain-analogue scale using the severity of "least pain" as an indicator of emotional response, and amounts of analgesics required. Breugel (1971) also examined the question of whether post-operative perception of pain was associated with pre-operative levels of anxiety. Anxiety as measured by the IPAT anxiety scale (Insitute for Personality and Ability Testing Anxiety Scale Questionnaire) which purports to measure the level of manifest free-floating anxiety did not function as a useful contributor to variance of perceived pain as determined by either the quantified pain rating or the amount of analgesic medication required. The investigator suggested that this lack of relationship was perhaps related to differences between characteristic and situational anxiety and that the anxiety which seemed to influence pain perception was induced by the situation and could most effectively be assessed by physiological measures such as plasma steroid level.

Chapman's (1973) study suggested that anxiety was a crucial component of the motivational-emotional aspect of pain and that the effective treatment of anxiety could do much to control the suffering associated with continuing pain. He studied the effects of Diazepam on human pain tolerance and pain sensitivity and concluded that Diazepam did not alter pain sensations, i.e. it did not affect the sensory-discriminative aspect of the pain experience. Neither did it function as a placebo in that a subject's willingness to report pain was reduced. Chapman's study suggested that the drug was analgesic only in the sense that it affected the motivational- emotional aspects of the pain experience and in so doing it reduced the aversive drive associated with continuing pain. He said that the importance of the motivational-emotional dimension of pain had been given too little attention. In problems of pain measurement the aversive drive properties of the pain experience were the major determinants of the pain complaint and the major factors in the limiting of the patient's daily activities. In a further study Chapman (1977) showed that presurgical levels of state anxiety and depression varied as a function of trait anxiety, (using STAI-state, STAI- trait, and Zung depression inventory). Trait anxiety was related to post- surgical pain, state anxiety and depression in general surgery and in surgery for renal recipient patients. However, the relationship was not demonstrated in surgery on kidney donors, suggesting that the meaning attached to the stress of surgery significantly effected the subjective state changes surrounding the operation.

Morgan (1978) showed that selected psychological states and traits were significantly correlated with the perception of pain. In a series of experiments he endeavoured to identify psychometric correlates of pain perception by means of a stepwise multiple regression procedure. The predictor variables included STAI-XI(State), STAI-X2(Trait), E.P.I. (Eysenck Personality Inventory), and measures of depression in the Adjective Check List and Profile of Mood States. He replicated his experiment. Extraversion was related in an inverse fashion to the rating of pain, consonant with related research demonstrating that extroverts (Lynn, Eysenck, 1961) have higher pain tolerances. Trait anxiety and neuroticism were thought to tap the same psychological construct. Morgan concluded that psychological traits such as extroversion, field dependence, anxiety and neuroticism, as well as psychological states such as depression and vigour were correlated with the perception of pain.

Dougher (1979) considered that the relationship between trait anxiety and pain behaviours remained an empirical question. He used the theory of signal detection analysis and showed that neither anxiety nor experimental instructions affected subjects' sensitivity to painful stimulation. The observed differences in pain thresholds reflected the influence of experimenter variables on the subjects' response criteria only. Anxious subjects established a lower criterion for reporting sensation as painful than did non-anxious subjects. Although this study indicated that anxious individuals were no more sensitive than non-anxious individuals to painful stimuli, the nature of the relation between trait anxiety and the tendency to report pain was unclear. It could not be assumed that state and trait anxiety operated in similar ways with respect to pain behaviours. Dougher saw the relation between the intensity of aversive stimulation and the reported intensity of pain as neither simple nor direct.

It could be useful to note here Over's (1978) attitude that clinical and experimental pain were not necessarily comparable, and that many experimenters may be pursuing the shadow rather than the substance of pain in a mistaken quest for methodological rigour. He said that much of contemporary pain research involved the use of refined psycho-physiological techniques in settings far removed from the natural environment in order to undertake rigorous investigations of the highly constrained behaviour of volunteers (usually students) while they are being subjected to minor, temporary and predictable irritation. The author was concerned whether an investigation studying experimental rather than clinical pain was inevitably forced into a narrow and limited perspective of pain in order to meet the methodological requirements and the convenience of the laboratory and concluded that experimental study of induced pain may constitute good psychophysics but may have little relevance to pain outside the confines of the laboratory.

II.2.2 EYSENCK'S PERSONALITY INVENTORY

Eysenck's Personality Index (EPI) has been used to look at personality correlates of pain. Morgan (1978) demonstrated that extraversion and neuroticism were correlated with pain. Lynn and Eysenck (1961) posited significant correlations between pain tolerance on one hand and extraversion and (low) neuroticism on the other. From Eysenck's theory of personality it may be deduced that pain tolerance should be positively correlated with extraversion and negatively with neuroticism. Extraverted subjects were postulated to develop inhibition/satiation more quickly and dissipate it more slowly; prolonged pain sensations should thus be inhibited more quickly and strongly in extraverts. Extraversion could be viewed from another angle. Physiological pain sensations were accompanied by the apprehension of future pain which may be seen as a conditioned fear response which added to the physiological pain. Extraverts were posited to condition less easily and therefore they would not develop this component of the total pain as much as introverts.

Dalrymple (1971) used the EPI and also took visual analogue pain measurements on 50 women having cholecystectomies, and showed a trend between neuroticism and subjective pain assessment. He also showed a significant relationship between neuroticism and chest complications, and concluded that a neuroticism score may have value indicating susceptability to pain.

Bond (1971) used the EPI and showed that pain-free subjects had low N (neuroticism) and high E (extroversion) scores. Patients who experienced pain but did not complain had high N and low E, indicating increased emotionality and a tendency not to communicate distress. Patients who experienced pain and communicated this had high N and high E scores. It seemed that the E dimension was important in determining the freedom and intensity with which the symptons were communicated. The presence of a raised neuroticism score was a pre-requisite for the development of a 'social desirability set' indicated by a raised L (lie) score. The presence of symptoms of disease was related to the N personality factor. Dalrymple (1973) looked at the L score in a later study of his in which he was again concerned with post-operative pain after cholecystectomy. He showed a significant relationship between the L score and subjective pain assessment, and cast doubt on the concept that the lie score was a measure of lying as proposed by Eysenck. To Dalrymple it seemed probable that these women with a high L score were more prone to exaggerate or choose extremes. In patients with a high L score, an increased pain score may indicate increased pain, but the L score may also represent a modified communication of the pain experience or response bias. He quoted an unpublished study by Morgenstern (1967) of chronic pain in amputees who found a higher L score than would be expected from a normal population. He noted that few studies related the L score to pain and more work would be required to understand the relationship.

Bernes, in 1975, reviewed literature relating to the EPI and pain thresholds, and used probability pooling, grouping comparable studies and carrying out overall tests of significance. His results supported a relationship between both extraversion and pain threshold and extraversion and pain tolerance.

Neuroticism has been demonstrated in relation to chronic pain. Liebeskind (1977) discussed the question of the personality profile of the chronic pain sufferer and refered to studies which report elevation in scales measuring neuroticism in pain patients, with a shift towards normality following surgery. Possibly personality variables were different for people with problems treatable by surgery and there was a predisposition for certain personality types to become chronic pain patients. McCreary (1979) looked at chronic back pain patients. Functional patients showed significantly more psychopathology, using the MMPI as a measure they produced higher scores on hypochondriasis, neuroticism (similar to N on EPI), and social intraversion (similar to -E on EPI). Hypochondriasis scores significantly predicted a poor outcome.

II.2.3 ABNORMAL ILLNESS BEHAVIOUR

Pilowsky (1979) was interested in abnormal illness behaviour or hypochondriasis and has developed an Illness Behaviour Questionnaire (IBQ)* which aimed to screen populations in order to identify those who may be expected to manifest abnormal illness behaviour of the 'somatically focussed, illness affirming' type. Patients answered Yes-No on a 62 item, self administered questionnaire. Scores were

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*
In this study AIBQ referred to the score derived from this discriminant function, involving the scales 2,3,6,7. IBQ referred to the Illness Behaviour Questionnaire and its 7 scales.

obtained on 7 scales which have been named: 1) General hypochondriasis; 2) Disease Conviction; 3) Psychological (high score) vs Somatic focussing; 4) Affective Inhibition; 5) Affective disturbance; 6) Denial; 7) Irritability. He carried out a discriminant function analysis to establish the linear combination of weighted scores that would be used as a screening instrument in General Practice populations to identify patients showing abnormal illness behaviour; he used a transformed function and added 71.465 to achieve a zero origin. This was an incorrect figure which Pilowsky admitted should be altered to 44.388 (Pilowsky, 1979, Page 204). (Moon, Pilowsky, personal communications, 1981)

II.2.4 OTHER PERSONALITY CORRELATES

Other personality correlates with pain have been investigated. Mumford (1973) looked at the relationship of personality measured by the Cattell 16 Personality Factor Questionnaire and pain perception threshold and pain tolerance level but showed no statistically significant correlation between any of the personality factors and either of the two pain measurements. Nor was there any correlation between pain perception level and pain tolerance level. However, his subject population was dental students who were familiar with the experimental situation and, therefore, not threatened by it so that both anxiety and fear of pain were diminished. Brown (1973) noted that correlations between pain responsivity and personality variables may depend on many nuances, including the level of pain-producing stimulation and on the manner in which measures of these variables are taken.

II.2.5 DEPRESSION

The relationship between depression and pain was not clear. In 1954, Hall investigated the varying responses to pain in psychiatric disorders and described both neurotic and depressive patients as verbally reporting pain and reacting to pain. Thresholds became higher with age. By varying the form of instruction given prior to his experiments he found it was possible to raise the response to pain considerably higher than the general average for the original condition, indicating that low tolerance for pain was often due to anticipation of pain rather than actual experience of it. Pilowsky (1976) discussed pain as a depressive equivalent, saying that the presence of depression (or any illness behaviour) seemed to modify the presentation of pain, and he referred to the wide use of anti-depressants to treat pain. Davis and colleagues (1979) demonstrated an overall analgesia among depressed patients. This relative pain tolerance in affective illness was in sharp contrast to the high incidence of the symptom or complaint of pain among depressed patients. Thus, while the authors may hypothesize that there is a failure of proper affective regulation of pain in depression (in the direction of more distressing clinical pain) other cognitive and sensory systems may shift homeostatically towards greater insensibility. The authors suggested that the pain insensitivity measured may select homeostatic changes to compensate for a failure of affective interpretation of somatosensory input. They went on to note preliminary, but indirect, evidence suggesting that endorphines may play a role in both the depressive mood and pain insensitivity of affective illness. Studies with narcotic antagonists in depressed pain- tolerant patients were suggested to determine whether a relative excess of endorphines may be responsible not only for the relative analgesia seen in these groups but also for the psychiatric symptom.

Depression was likely to occur in the population being studied without being necessarily linked with pain. Melody (1962) noted that 4% of women showed depression post-operatively within three months of surgery, and that a history of previous depression was a predictor. Henker (1964) claimed that there was a higher percentage of women operated on for hysterectomy in psychiatric hospitals than in the general population. Admission to a mental hospital for a first admission in hysterectomized patients was highest in the 30-39 age group, i.e. in the pre-menopausal age group (Bragg, 1965). Fahy (1973) suggested that depression after hysterectomy in women with a history of depression was endogenous rather than reactive and he advised counselling of women about the desirability of incurring the risk of further depression by obstetric procedures such as hysterectomy.

Richards, (1973) gave high figures relating to depression after hysterectomy; 36.5% of 200 women who had a hysterectomy were treated for post-operative depression by their general practioner; 55% of women operated on under the age of 40 had post-operative depression; and 65.5% of women who had had pre-operative depression developed such symptoms again after surgery. He noted the need for circumspection before deciding on hysterectomy as an operation of choice in women under 40, women with a history of depression, and in women with no demonstratable disease. Mills, (1973) countered this by describing the follow-up of between three and ten years carried out on 100 women whose hysterectomies were performed before the age of 36. Only four were found to have had significant depression and three of these women had been under psychiatric care at the time of the operation. He considered that two principles were involved in the avoidence of post-hysterectomy depression: it should be appreciated that women under physical, social or emotional stress may present with pelvic symptoms and if symptomatic relief was attempted by hysterectomy there would be inevitably a high rate of subsequent depressive illness; also required was a vigorous pregramme of post-operative rehabilitation including teaching about the importance of rest over the early months.

The Zung questionnaire on depression was used by Moore

(1976) on the day before surgery and also 12 weeks later. Of women who were depressed before the operation 64% were depressed 12 weeks later, and of those who were not depressed pre-operatively, 13% were depressed 12 weeks later. In total, 34% were depressed post-operatively. The incidence of depression did not change as a result of hysterectomy. There was a clear correlation between pre- and post-operative depression.

Meikle (1977) countered previous findings in a study that lent no support to the view that the removal of the uterus led to greater emotional disturbance than other forms of equivalent surgery and suggested that previous findings to the contrary were generally based on inadequate design and deficient analyses of results.

II.2.6 PAIN HISTORY

Chronic pelvic pain showed considerable psychopathology clinically and by psychological testing and such patients were usually keen to undergo surgery according to Castelnuova-Tedesco (1970). Chronic pelvic pain appeared to be more closely related to the presence of psychiatric disturbance, which was a constant finding, than to the presence of organic pelvic pathology, which was an inconsistent finding. Therefore, history of pain prior to surgery was relevant. Ellis (1971) also noted the importance of the patient's own past experience which he said should not be under-estimated and probably could not be overestimated, as a person was conditioned by past experience to expect/endure pain. Past experience was also important to Young (1976) who said the polysurgical patient psychologically was more at risk from surgery. He also noted the presence of chronic pelvic pain and of moderate-severe neurosis. The amount of post-operative counselling and emotional support could compensate for ill-advised and thoughtlessly performed surgery.

II.2.7 PERCEIVED CONTROL

Coyne (1978) discussed pain and depression as a function of the effectiveness of perceived control. Subjects who saw themselves as having control over aversive stimuli showed fewer decrements in performance and greater tolerance of frustration following exposure to such stimuli than subjects who did not. Greer (1970), Glass (1975), Wortmen (1975) showed that subjects experienced less autonomic reactivity to stressful stimuli when they perceived themselves to be in control of those stimuli. Scott (1977) demonstrated cognitive control of pain, saying that pain experienced could be reduced by attempting not to be bothered by the pain, concentrating on other things, dissociating oneself from the pain, reinterpreting the sensations as not painful, and imagining that the stimulated area was numb and insensitive. He concluded that it was easier to change tolerance of pain than to change the perception of pain or the distress produced by it.

II.2.8 HOSPITALIZATION STRESS

The stress of the hospital experience itself should not be overlooked. Volicer (1978) measured such stress on the Hospital Stress Rating Scale and showed that patients scoring high on hospital stress tended to report more pain, have lower physical status during hospitalization and showed less improvement after discharge than patients scoring low on hospital stress.

II.2.9 SUGGESTION

Pain was also altered by placebo and suggestion. Egbert (1964) had a "special care" group of patients about to undergo abdominal surgery, who were seen by the anaesthetist before surgery, and were given an explanation of post- operative pain in terms of localised muscle spasm, and were instructed that relaxation of the abdominal muscle, would assist. These patients required significantly less narcotics post-operatively than a control group. Melzack (1963) demonstrated the effectiveness of suggestion together with intense auditory stimulation as a strategem for achieving control over pain. The auditory stimulation appeared to provide a "tool" for diverting attention away from the pain when paired with strong suggestion that it would do so - neither alone was as powerful. Evans (1971) investigated the effects of suggested analgesic and hypnotic states with regard to reduction of stress responses and concluded that suggestion and not hypnotic induction procedures, produced reduction in the self-report of stress. Neither suggestion nor hypnotic reduction procedures resulted in the reduction of physiological stress responses (heart rate, pulse volume). Xu Shu-lion (1980) looked at suggestion factors in acupuncture analgesic and ascertained that word-induction suggestion played some role which was, however, uncontrollable. Suggestion could be positive, but even when negative it could actually contribute to the "mental" preparation for pain stimulation and help alleviate that pain sensation. Clinically, the author found that suggestion may play some role, although it was not essential in the reduction of pain.

II.2.10 EDUCATION

The relationship, in a given patient, between pain and various emotional phenomena, was one of the most difficult to untangle clinically. Ramsey (1979) noted that acute pain due to readily discernable injury was less complicated in its understanding than chronic, intractable pain, but said that the lesser complexity of acute pain did not prevent its modification by factors other than strictly organic ones, and he emphasised the need for education about pain.

II.3 MEASUREMENT OF PAIN

Virginia Woolf said, "let a sufferer try to describe a pain in the head to the doctor and language runs dry". If a patient were asked to describe pain the reliability of an introspective judgement was questioned; and if that patient had to stop and think of how to describe his pain his judgement became retrospective rather than introspective. (Parkhouse, 1963) Parkhouse noted that researchers tended to study "pain at rest" but that pain at rest may not necessarily be the most important aspect of the patient's suffering as avoidance of chest complications and venous thrombosis involved movement. Hilgard (1969) advocated magnitude estimation of pain, saying that there was no physiological measure of pain which was either as discriminatory of fine differences in stimulus conditions, as reliable on repetitions or as lawfully related to changed conditions as the subject's verbal report.

II.3.1 ADJECTIVE LISTS

Adjective lists containing both sensory and affective words can be used to give the magnitude of sensation. Gracely (1978) validated the use of verbal descriptors quantified as stimuli in the absence of noxious sensations to measure sensory pain intensity. Pain affect was considered to be determined by anxiety, so in an experiment he used Diazepam as an anxiety reducer, knowing it did not appreciably alter sensory sensitivity. The results of using Diazepam as an independent variable showed that only the affective word descriptor scale was depressed following administration - the sensory word adjectives were unaltered. Melzack and Torgeson (1971) began to clarify the description of pain by providing a specific vocabulary, through use of which sufferers may choose those words descriptive of their perception of pain. The sets of words seem to cluster in three domains, to represent several characteristics of pain within each domain and to represent degrees of severity within each domain. Those domains have been labelled the sensory, the evaluative and the affective and their existence may be consistent with some current concepts of pain. Leavitt (1978) used this scale to study responses from patients with chronic back pain and their reports fell into seven distinguishable patterns, the first of which accounted for 39% of the variance and referred almost entirely to emotional discomfort. The second pattern accounted for 9% of the variance and was a mixed emotional and sensory factor. The remaining five patterns accounted for 29% of the variance and constituted an entirely sensory class of factors.

II.3.2 SIGNAL DETECTION THEORY

Crawford Clark (1974) used signal detection theory (SDT) which emphasised the distinction between the pain experience itself and an individual's criterion for reporting that pain. SDT made it manifest that an altered pain threshold did not, as is usually inferred, prove that pain sensitivity had been affected. Grossberg (1978) also noted the value of SDT in the separation of human decision-making into a discrimination accuracy measure and a criterion or base measure. He saw this as useful in pain assessment when any number of impressive procedures could and did affect the person's willingness to report pain but left unaffected the detectability of pain-producing stimuli. He considered it useful to regard pain as a global sociobehavioural interaction involving neurophysical, hormonal, anatomical, social, economic and psychological components, and that a choice of measure should be dictated by whatever aspect of the global pain complex was of primary interest.

II.3.3 PAIN THERMOMETER

The "pain thermometer" has been a common choice of measure in clinical research. Joyce (1968) used a thermometer-shaped drawing of standard length with only the "bulb" and "sharp end" labelled as "pain completely absent" or "pain completely intolerable". Aitken (1969) said that communication based on a simple visual analogue seemed appropriate, with boundaries clearly defined as the extremes of feeling. He and Hornblow (1976) discussed characteristics of visual analogue scales, including the tendency for distribution of raw scores to be skewed. An appropriate non-linear transformation which was recommended to achieve normal distribution of scores was the arcsin transformation. Hutchinson (1974) said that of the various methods of measuring pain the visual analogue scale seemed to be the most sensitive but advocated a pain-relief scale instead of a pain scale. Magnitude of the response did not depend on the initial pain severity, and it was more usual for patients to express themselves in terms of pain relief, e.g. "my pain is a little better". He said that pain was a personal psychological experience and that an observer could play no legitimate part in its direct measurement.

Frederiksen (1978) suggested strategies that would improve measurement of pain including multiple objective and multiple subjective measures. Since pain was not necessarily a unitary phenomenom any relationships among various characteristics of pain must be empirically established and not assumed.

II.4 MORPHINE AND PAIN

Very little relationship was shown between patients' rating of pain intensity and analgesic administration by hospital nursing staff (Bond 1966). In 1959, Beecher and associates looked at results of the relief of post-surgical pain through morphine. About a third of the patients gained relief of pain through morphine that was greater than the relief following a placebo; about a third got as much relief from a placebo as they did from morphine; the final third were relieved neither by placebo nor by morphine in doses considered safe to use. Hill (1952) considered that morphine relieved pain only when anxiety was present. Egbert (1967) compared patients with confidence and patients without confidence to see if they differed in the numbers of milligrams of narcotic (calculated as equivalents of morphine) administered from midnight to midnight of the first day of operation. Patients confident of a good outcome from surgery had 25.2 plus or minus 13.5 mg. per 70 kilograms of body weight and the no-confidence group were given 43.5 plus or minus 22.1 mg. per 70 kg. The difference between these groups was significant at the .01 level. Belville saw an age effect in relation to morphine. In patients receiving 10mg of morphine for acute post-operative pain there was a high correlation between age and pain relief reports. Older patients reported, on average, lower mean levels of initial pain, and at the same time they reported a higher degree of pain relief following narcotic administration.

II.5 ELECTROMYOGRAPH

Measures of muscle activity were made electromyographially before and after surgery. The property of striated muscle is contraction, and the structural unit of contraction is the muscle cell or fibre which is a fine thread of up to 30 cms in length and only 100 wide that on contraction will shorten to about 50% of its resting length. (Haines, 1934). A muscle contraction appears smooth as if all its fibres were in synchrony, but the activity of its individual fibres alters rapidly and the apparently smoothe contraction is the summation of all those rapid changes.

All the fibres within a muscle contracting simultaneously are supplied by terminal branches of one nerve axon whose cell body is in the anterior horn of the spinal grey matter. This cell body and axon running down the motor nerve plus its terminal branches together constitute a motor unit which is the functional unit of striated muscle. An impluse descending the axon causes all the muscle fibres in one motor unit to contract simultaneously. (Basmajian 1957).

The electromyogram (EMG) is the electrical manifestation of neuro- muscular activity associated with a contracting muscle. The bioelectric potential is the ionic voltage produced as a result of the electro-chemical activity of the muscle cell. The muscle cell is encased in a semi-permeable membrane and is surrounded by tissue fluids containing ions of sodium, potassium, and chlorine. The membrane allows the $K+$ and $Cl-$ ions to enter the cell readily, but not the $Na+$ ions, resulting in a lowered concentration of $Na+$ ions inside the cell with the result that the outside of the cell is more positive than the inside. Although $K+$ ions tend to move inside to balance the charge this cannot be achieved because of the imbalance of $K+$ ions. Thus, at this stage the cell is described as being polarised and has a negative resting potential.

Excitation of the cell membrane by a nerve impulse at the myo-neural junction elicits a depolarization of the cell membrane with the result that $Na+$ ions enter the cell. $K+$ ions tend to move out but move more slowly. The cell, therefore, becomes slightly positive because of the imbalance of $K+$ ions. The action potential of the cell is positive. The movement into the cell of $Na+$ ions causes an ionic current flow that further reduces the barrier of the membrane to $Na+$ ions. Once equilibrium is reached the cell membrane becomes selectively permeable again. A sodium pump, relating to the presence of high energy phosphate compound but not readily understood, transports $Na+$ ions to the outside of the cell again against both charge and concentration gradients.

The actual voltage being measured at the skin from muscle cell activity is a complicated integration from the adjacent muscle cells. Each individual motor action unit potential is triphasic - fine wire inserted electrodes can record a single motor unit firing and the wave form can be observed on an oscilloscope. Each cell fires repeatedly, giving a motor unit action potential train. During a muscle contraction many different motor units are firing asynchrously at once, and surface electrodes reflect the sum of all of these.

The exact method by which these potentials reach the skin surface is not yet known, nor is the exact mechanism by which it is recorded understood. One explanation was that sequences of changes of these potentials appear to reach the surface as variations in the concentration of those metallic ions in the body fluids that characterise the polarization and depolarization of the cell membrane during muscle activity. The electrical potential between those metal ions in solution and the metal electrodes may be detected by having two metal electrodes (usually silver/silver chloride) complete a circuit by being in contact with body fluids via the skin. The actual signal detected is the algebraic difference between the potentials at the two electrolyte surfaces at any one instant, (analogous to a torch battery). (Cromwell, 1973). De Luca (1978) suggested the possibility that the membrane depolarization accompanied by a movement of ions generated an electromagnetic field in the vacinity of the muscle fibres, and that this flow could be detected by recording electrodes in relation to a ground electrode.

II.6 RELAXATION

Simple relaxation techniques appeared effective with chronic pain but their effectiveness with acute pain required further clinical application and evaluation. Grzesiak (1977) claimed that methods of teaching relaxation were efficient and pragmatic, with only one therapist being required to teach the technique after which the patient was encouraged to practice independently; the attitude to pain was altered; alleviation of pain gave partial relief of hopelessness and depression; he further noted that relaxation precedures had fared well in the treatment of anxiety states, presumably because anxiety and relaxation were organismically incompatable states. This concept was developed by Wolpe (1958) in his theory of psychotherapy by reciprocal inhibition in which he said that anxiety and relaxation were antagonistic entities. Thus, when an individual was anxious he could not be relaxed and when he was relaxed he could not be anxious. Bobey (1970) investigated the use of relaxation along with other cognitive strategies to train coping mechanisms to deal with physical pain, and showed that relaxation techniques were the most effective method of dealing with a painful stressor.

Wickramasekera (1973) discussed the meaning of the word 'relaxation', saying that it was more complex than was previously thought. Clinically it seemed that the major subgoal in relaxation training was to induce in the patient the subjective feeling of "letting go" which, when it occurred, seemed to increase the malleability of behaviour. Subjectively, the experience of 'trust' and 'letting go' seemed to be similar. The development of reliable and effective precedures for altering or shaping subjective responses (i.e., private events) could contribute saliently to a reliable and powerful technology of behaviour control. Wickramasekera noted that this subjective feeling of 'letting go' had been recognised previously in Yoga and Zen and was currently coming into increasing recognition in 'altered states of consciousness' induced by a variety of agents (e.g. alpha, LSD).

When electromyographic techniques were first developed, researchers looked for and found high correlations between subjective feelings of relaxation and muscular relaxation (Reusch, 1943).

Malmo (1951) posited a general factor of muscular tension in some individuals and noted the skeletal-motor aspect of emotional states as important. Lundervold (1952) said that electrical activity in a resting healthy muscle indicated whether a person was tense or nervous, and that this could be recorded in a great number of muscles in the body. He noted a preponderance of women who were tense and said that muscles seemed to be in a state of constant readiness so that a stimulus considerably less than normal was required to evoke a muscle contraction. Muscle reflexes in healthy subjects had marked changes when that person was under emotional stress according to Bowman, (1968) who showed an increase in the myotatic jerk amplitudes of subjects under stress.

Normal muscle at rest gave no sign of neuromuscular activity. Basmajian (1979) said that most neurophysiologists agreed that the electromyogram (EMG) showed exclusively the complete relaxation of normal human striated muscle at rest, i.e. by relaxing a muscle a normal human being could abolish neuro-muscular activity in it; this has been confirmed by multiple electrode recording. Basmajian defined muscle tone as being a function of the nervous system controlling muscle, but said it also resulted from the natural elasticity of the muscular fibrous tissue. He said that at rest a muscle relaxed rapidly and completely. The reaction time of muscular relaxation in the elbow flexors was investigated by Miyashita (1952) who found no difference in reaction times between muscular relaxation and muscular contraction. He noted significant individual differences between people.

II.7 BIOFEEDBACK

Biofeedback was the technique used in this current study specifically to train relaxation. A simple definition of biofeedback was given by an initiator, Barbara Brown (1974) who waid it was "simply the feedback of biological information to the person whose body it was". Marcus (1977) said biofeedback was an educational method in which ordinarily unavailable information about variations in an individual's own bodily processes was presented continuously to him, enabling him to make adjustments to those bodily processes that would have been impossible or difficult without the information fed back. Biofeedback techniques have been used as a means of reducing the general level of arousal, as do meditation (Bensen 1975), progressive relaxation (Jacobson 1929), autogenic training (Luthe, 1971), physiological relaxation (Mitchell, 1977). These latter methods may be preferable because less paraphenalia are required. However, biofeedback monitoring had the special advantage of permitting the systematic objective measurement of arousal under different levels of stimulus activity. Arbogast (1978) saw the greatest advantage of biofeedback possibly as lying in its diagnostic function, saying that traditional psychotherapy may take many hours to establish a link between some emotional stress and a physiological event whereas, with biofeedback techniques, that link between mind and body may become more rapidly detected. Reinking (1975) compared methods of relaxation training, using electromygraphic feedback of forehead muscle activity, Jacobson-Wolpe relaxation instructions, a combination of those, feedback with a monetary reward, and a control group and showed that in speed of learning and depth of relaxation forehead feedback groups were superior.

Qualls (1981) reviewed 150 studies of biofeedback in which monitoring of the frontalis muscle region was used as a means of training general relaxation. She concluded that this method appeared to be an effective procedure that compared favourably with other techniques and noted that most research essentially ignored inter-subject differences, which obscured the finding that EMG biofeedback was an effective procedure for some but not all individuals.The author challenged the recent trend of concluding in favour of alternative relaxation procedures in terms of a cost-benefit analysis of their utility. She saw a danger that the wake of biofeedback may occur and that biofeedback would be abandonded as a relaxation procedure before it had had a chance to mature.

Electromyographic biofeedback methods were used in this study but it was noted that many modalities of feedback were available and have been used to both reduce pain and treat anxiety; for instance, Grim (1971) used respiration feedback to induce relaxation and he showed decreased anxiety.

The relation between anxiety and muscle activity has been investigated over a long period. In 1954, Sainsbury showed that the resting level of frontalis activity was higher in tension headache patients than in normals. Balshan (1962) looked further at the activity of the frontalis muscle in a study that measured EMG in 16 muscle groups in search of a general factor of muscle tension. The failure of the frontalis muscle to co-vary with the other muscle groups was noted, and it appeared that those muscles that were the most difficult to relax were the ones that showed very little relationship with a general muscle factor. Although no actual figures were given in the article the authors said that mean EMG for frontalis and the sterno-mastoid muscles far exceeded the levels reached by other muscles during rest. In a further study with Goldstein (1965) it was noted that very little difference in muscular tension occurred between psychiatric patients with a diagnosis of hysteria or neurosis compared with normals. In 1966 Rimon conducted an EMG study of depressive patients and claimed that the degree of depression, measured on Beck's Depression Inventory, correlated with residual muscle activity in the masseter muscle, the forearm and the forehead.

The study of frontalis and anxiety continued. Raskin (1973) showed frontalis EMG biofeedback training together with daily practice of relaxation to be moderately useful for patients with chronic anxiety. In a controlled study Townsend (1975) compared chronically anxious patients who were given EMG frontalis biofeedback training to a matched control group given psychotherapy and found that the feedback group showed significant decreases in EMG levels, mood disturbance and trait anxiety, and, to a lesser extent, state anxiety. Cox (1975) showed a reduction of EMG (frontalis) accounted for 18% of variance in treatment effect in the treatment of tension headache. Earlier, Budzynski (1973) had given a 0.9 correlation between reduction of headache activity and the reduction of frontalis activity. He considered skeletal muscle activity to be the most reliable single correlate of physiological arousal. Coursey (1975) studied EMG feedback as a relaxation technique but said an integrated recording of multiple muscle groups was required as an analogue feedback from a single muscle group did not generalise relaxation across the body. He found a low relationship between recorded EMG frontalis level and self-rated anxiety. Poor generalisation between the forehead muscles and the whole body was also described by Alexander (1974) and he considered that the reason may be that the popularly used frontalis muscle did not correlate with the general tension factor described by Balshan (1962) after analysis of 16 muscle groups. In 1977 Alexander stated that the use of EMG biofeedback relaxation as a training technique was based on the assumption of generalisation of muscle tension reduction to other muscles accompanying reduction in some key muscle (usually frontalis) and upon claims regarding the presumed low arousal state which was said to result from the reduction of tension in that particular muscle. He said that transfer of learning from one muscle site to another did not occur and that the notion of some sort of generalised relaxed state resulting from one muscle site biofeedback training was naive. That assumption of generalisation persists. Blanchard (1976) used auditory analogue feedback from the frontalis area and found a significant reduction in systolic blood pressure in normatensive subjects, and he presumed that this result occurred because of a central relaxation effect. In 1979 Bruhn claimed feedback from frontalis to be an effective treatment for muscle contraction headaches and again assumed that frontalis relaxation training generalised to other head and neck muscles.

Frontalis muscle tension and personality were studied by Smith (1973) who criticised earlier studies that looked at relationships between personality and electromyographic levels for muscles at rest as they were usually carried out on psychiatric populations, making generalisations to normal populations questionable. In addition technology used in some earlier studies seemed open to criticism. Therefore, he examined correlatives between personality traits and resting frontalis EMG levels using a non-psychiatric population. EMG measures were taken of frontalis over 2 x 20 minute periods in a darkened room and the mean of these scores was compared with seven personality test scores using Spearman rank correlation co-efficients. Resting Frontalis EMG showed a positive correlation with trait anxiety and with covert/overt anxiety as measured by Cattell's IPAT. Neuroticism measured by EPI, and external locus of control measured by Rotter were also related to resting frontalis EMG. No significant relationship was observed between state anxiety and frontalis EMG or between introversion (EPI) and frontalis EMG.

Osborne (1978) used the MMPI to study the relationship between skeletal muscle activity and personality variables. Again, EMG was measured over frontalis. He found a significant relationship between scale L and muscle activity which suggested to him that persons with greater objective tension were more rigid and naive than were persons with lower levels of muscle activity. Persons with high levels of tension were likely to use denial as a defence mechanism and lack insight. A significant relationship between scale D and frontalis activity was also found and was interpreted to mean that persons in the low tension group were less likely to feel social anxiety and were not likely to conform to the demands of others as were persons in the high tension group.

However, not all research substantiated such findings. Hardt (1978) said that anxiety changes were generally unrelated to either resting levels or changes in frontalis electromyographs or to respiration rate, and were more likely to be related to alpha activity as monitored by electroencephalic recording apparatus. Alpha feedback has been used to train self-regulation of pain, by Melzack (1975). Chronic pain was reduced in 58% of subjects by using a combination of alpha feedback training, hypnotic training and placebo effects. Replication is required in this area.

EMG feedback has been used as a training technique aimed at reducing pain. Wickramasekera (1972) showed that subjects receiving contingent EMG feedback from the frontalis muscle reduced the frequency and intensity of headache activity. However, he did not give a statistical analysis of his results and only assumed that changes in EMG and headache activity were significant. Hendler (1977) used EMG feedback in the treatment of chronic pain, monitoring frontalis because of the varying sites of pain in his subjects. Six of thirteen subjects reported improvement but there was no correlation of muscle tension reduction to pain reduction. He used the MMPI, which did not substantiate anxiety reduction as a contributing factor to the relief of pain. He explained the beneficial effects of the biofeedback training for the responders in terms of a sense of mastery over their environment with resulting reduction of obsessive concern over their somatic problem, together with improvement of their self-esteem as a result of their increased environmental control. Turk (1979) reviewed studies of pain and biofeedback training, saying that rarely was biofeedback alone used and he noted the importance of home practice. The studies he reviewed did not reveal consistent results. The evidence for biofeedback per se in reducing pain was marginal at best, resting mainly on case studies and poorly controlled research. They were not necessarily any more effective than other relaxation and cognitive control techniques available. He concluded that evidence for the widely acclaimed benefits of biofeedback training were lacking and that biofeedback techniques were only a research tool at this time. Alexander (1973) also showed that there were no differences between biofeedback-relaxation subjects and those subjects relaxing alone on such measures as skin temperature, decreased heart rate, skin temperature, developed heart rate, skin conductance and state anxiety.

II.8. MUSCLE ACTION

Measures of both forehead and rectus abdominis electromyographic activity were used in this study, so their action needed to be understood.

II.8.1 FOREHEAD MUSCLE ACTIVITY

Most studies discuss frontalis muscle activity. Malmo (1955) measured muscle tension on six muscle sites on arms, neck, face, and concluded that frontalis gave the most sensitive discrimination between normal and anxious subjects; and he related the frontalis muscle to a factor of motor restlessness. He examined the question of whether the frontalis potentials were due to an EEG artifact or to a blink artifact and concluded against those. To quote Malmo, "the temptation is strong to exploit frontalis muscle tension as an index of emotionality, but such exploitation is unwise". He went on to say that increased EMG in frontalis accompanied concentration, as when listening to a story, so that an explanation of the muscle activity must entail cognition as well as emotion.

But, was frontalis muscle activity alone being recorded? Hume (1977) said that surface electrodes did not, by and large, provide information from just one muscle even when accurately placed at either end of that muscle. What was recorded was the average of the activity from several adjacent and not-so- adjacent muscle, e.g. monitoring "frontalis" can record activity in all forehead, throat, mouth, jaw, chest and oesophageal muscles. It was more accurate simply to specify the electrode placement used and to describe changes in the activity so recorded then to claim that this activity came from a particular defined muscle. Hume said there was now reasonably consistent evidence that feedback of EMG activity recorded from the forehead (putative frontalis activity) produced a greater reduction in this activity than general relaxation procedures. He noted the haphazard manner of investigation of stress and anxiety and while not doubting that EMG feedback from the area of the frontalis muscle was associated with a generalized reduction of subjective tension and related symptoms, he said there was little convincing evidence that EMG biofeedback relaxation was superior to relaxation produced by other means.

Basmajian (1979) said that EMG from the forehead need not come from the frontalis muscle. Indeed, a wide source of myopotentials was to be preferred as a reflection of general nervous tension. He noted that the wide source myopotentials were not "frontalis EMG" and that the number of microvolts simply indicated a microvolt reading at the input of the device. The integrated EMG from forehead surface electrodes generally reflected the total or global EMG of all sorts of repeated, dynamic muscular activities down to about the first rib along with some postural activity and nervous tension overactivity.

The specific action of the frontalis muscle was to elevate the eyebrows or to frown with the forehead and its direct antagonist was the procerus muscle. Frontalis activity decreased in the supine position. At rest, frontalis was silent and became active on demand or in response to specific (perhaps uncontrolled) emotional states and expressions. (Besmajian, 1979).

Peffer (1979) said that using a 100-1000 Hz bandwidth, amplitudes around 0.5-1.0 microvolts average were typical in relaxed muscles in the forehead area and that for headache sufferers readings could be as high as 10 microvolts averaged.

II.8.2 RECTUS ABDOMINIS MUSCLE ACTION

The action of the rectus abdominis muscle was identified electromyographically by Floyd (1950) who placed one electrode on the upper part of rectus abdominis between the xiphisternum and the umbilicus and the other 10 cms below the umbilicus. At rest in the supine position with the head of the couch raised 30 degrees there was no discharge from the rectus abdominis muscle and only a slight discharge from the abdominal oblique muscles. The dominant role of the rectus muscle in this position was head raising. Campbell (1952) showed the abdominal muscles as being the only indisputable muscles of expiration in humans, with the oblique and transverse muscles being much more important than the rectus abdominis. De Sousa (1974) showed that the rectus abdominis muscle was inactive in all its segments during normal respiration in the supine position and was also inactive in the orthostatic position, i.e. it did not have any postural activity. It showed action of the end of forced expiration but was not essential in that activity.

Basmajian (1979) demonstrated that multi-recording from various parts of the rectus abdominis muscle showed that while the subjects lay supine and resting no activity was found in persons who looked comfortable and relaxed but slight activity was seen in nervous persons although this could be reduced or abolished by careful positioning. No inspiratory or expiratory activity in the abdominal muscles was seen during quiet breathing. Nayman (1978) said that after operations the respiratory function of the abdominal muscles was impaired. The pain experiences by the patient prevented him or her from fully utilizing the abdominal and accessory muscles of respiration. There was a decrease in the movement of the diaphragm and the thoracic cage was relatively immobile. The decrease in respiratory excursion resulted in decreased aeration of the pulmonary alveoli and was often followed by collapse of the lung and subsequent infection. He claimed that better control of pain would break this cycle, ensure adequate respiratory movement and reduce incidence of post-operative chest complications. He concluded by saying that the control of post-operative pain was standardized, and not modified to the needs of each particular patient.... it was as if the mind had been dissociated from the body, the patient from the operation.

A further comment on the implication of the abdominal muscles came from Adler (1979) who said that psychologically dysphoric states such as anxiety and depression had accompanying physiological changes. Like symptoms, the psychological defenses against symptoms also had somatic components coincident with and integral to them. Some patients braced their striate musculature in defensive posturings. Tightening the abdominal muscles to prevent crying was one example of this.

II.9 BIOFEEDBACK IN POST-OPERATIVE TREATMENT

Three studies have used EMG biofeedback to assist relaxation in the post- operative period. Lichter (1978) studied patients undergoing major elective surgery requiring thoracotomy. They were given several pre-operative training sessions using both practice tapes and forehead EMG feedback, and were instructed to use relaxation in the post-operative period whenever they felt it might be of assistance in relieving pain. A statistical analysis of results did not demonstrate a significant benefit from this form of management. He noted the multiplicity of factors responsible for the known variability in post-operative pain, including personality, cultural background, attitude, motivation, past and present experience, expectation from the operation, anxiety, suggestion and the nature of the operation. Certain findings were not subject to objective evaluation; it was observed by physiotherapists that patients trained in relaxation were calmer and more co-operative than those who were not. A reduction in muscle spasm was noted and after breathing exercises relaxation was rapidly achieved. Post-operative physiotherapy was carried out with greater ease and efficiency. In 1979, Madden looked at the effect of EMG biofeedback on post-operative pain following abdominal surgery, and concluded that EMG biofeedback was an effective method of pain relief only when feedback was given from the muscle site involved in the operation. Only 12 subjects were in the study, allocated randomly to three groups; 1. EMG feedback from abdominal muscles with electrodes seemingly arbitrarily placed on the abdominal wall; 2. EMG feedback from the frontalis muscles; 3. No EMG treatment. Frontalis muscle EMG feedback was not found to be effective in reducing pain of abdominal origin. EMG readings were typically higher for the abdominal muscles than for the frontalis muscle. The small number of subjects in this study limited generalizability. Perri (1979) used relaxation training to reduce pain following vaginal hystrectomy. Two 90-minute training sessions were given preoperatively in progressive muscle relaxation, and subjects' pain was assessed postoperatively on self-reports of pain, observations made by independent observers and by the number of pain medications received. No significant differences between the trained subjects and a control group were noted; the author commented that relaxation training may not have been a sufficient procedure because of insufficient training, a lack of staff reinforcement for the subjects' post-operative use of relaxation, and the availability of "easier" methods of pain control such as medication.

III METHOD

III.1. THE SUBJECTS

The subjects in the trial were patients admitted to Christchurch Women's Hospital between September 1980 and March 1981. They were referred by their general practitioners for consideration for hysterectomy and were assigned to the various medical specialists by clerical staff using criteria unrelated to this study. Because of constraints on availability of equipment and time, patients in the experimental groups were those having surgery on two particular days of the week and patients operated on on other days formed the control group. Allocation to feedback/ no-feedback groups was made on alternate weeks so that subjects in one ward at the same time were in the same experimental group, to avoid confusion among the subjects if they discussed the procedure with each other. Patients were given written information explaining the nature of the investigation and were given the opportunity to discuss this. All subjects approached agreed to take part in the experimental groups; two wanted to withdraw on the first post-operative day but with a little persuasion agreed to stay in the study. Three subjects who were asked to be in the control group declined. Two subjects were dropped from the experimental group because of incomplete data collection due to factors outside the study, (death in family, self-discharge).

Two surgical procedures were used for the operation; either the abdominal wall was resected or the approach was through the vagina. Experimental and control subjects were in both surgical groups. The decision as to which procedure was appropriate was a medical one, often not made finally until at operation. This in part lead to an imbalance in the size of subject groups.

III.2 EXPERIMENTAL DESIGN

Data was collected from a total of 73 patients, grouped as follows:-

	Hysterectomy Operation		
	Abdominal :	Vaginal :	Totals
Experimental, Feedback:	16	9	25
Experimental, No Feedback:	14	10	24
Control:	16	8	24
Totals:	46	27	73

In the year 1980/81, 234 women were admitted to Christchurch Women's Hospital for abdominal hysterectomy and 158 for vaginal hysterectomy. Thus 60% had a hystrectomy by abdominal incision. In this study, 63% of women had an abdominal hysterectomy. This sample, therefore, was a representative sample, being 18.6% of the annual hysterectomy population within this hospital and was believed to be representative of women admitted to public hospitals in New Zealand.

Experimental Procedures were as follows:-

Groups:	Analogue Tone:	EMG Measures:	Psychological Tests:	Pain Analogue:	Morphine Measures:
Feedback	X	X	X	X	X
No Feedback	-	X	X	X	X
Control	-	-	X	X	X

III.3 ELECTROMYOGRAPH MEASUREMENT

The EMG biofeedback unit, built by the Medical Physics Department of Christchurch Hospital, had two matched channels with high sensitivity, effective artifactual and environmental noise filtration, facility to effectively cancel out the average internal noise and to check the electrode- skin conductance and power supply protection for the patient. Average EMG levels were displayed. Analogue tone auditory feedback and sensitivity of this output to input EMG could be set to suit.

III.3.1 SYSTEM DESCRIPTION

a.) Input stage:

1. Fixed gain amplifier multiplied signals of from 1 microvolt to 1 millivolt by a factor of approximately 1000 (giving range 1mV to 1V).
2. Filterblock. a) a notch filter at 50Hz to removed mains frequency.

   b) The filter cut-offs to allow EMG frequency were at 6 dBs per octave

above 200 Hz and at 30 dBs per octave
below 100 Hz, giving a band
width of 100-300 Hz
(see foot note below*).

3. Amplifier, the gain of which was set by the operator, bringing the fluctuating signal level up to 0-3 volts.
4. A Rectifier converted the signal which was fluctuating on both sides of zero to one fluctuating on one side only, and from this an average was obtained that was not zero.
5. The averager removed all the rapidly fluctuating components and showed on the meter the current average signal value.

b.) Output stage:

Continuous averages were monitored for each channel on two meters. Each channel could be selected independently for auditory feedback, or the two channels could be summed, each being halved first to give the average of the channels. The long-term averager integrated the output from each of the channels for a pre-set time (each 60" in this study) at the end of which the meters indicated the average level of the

---

*

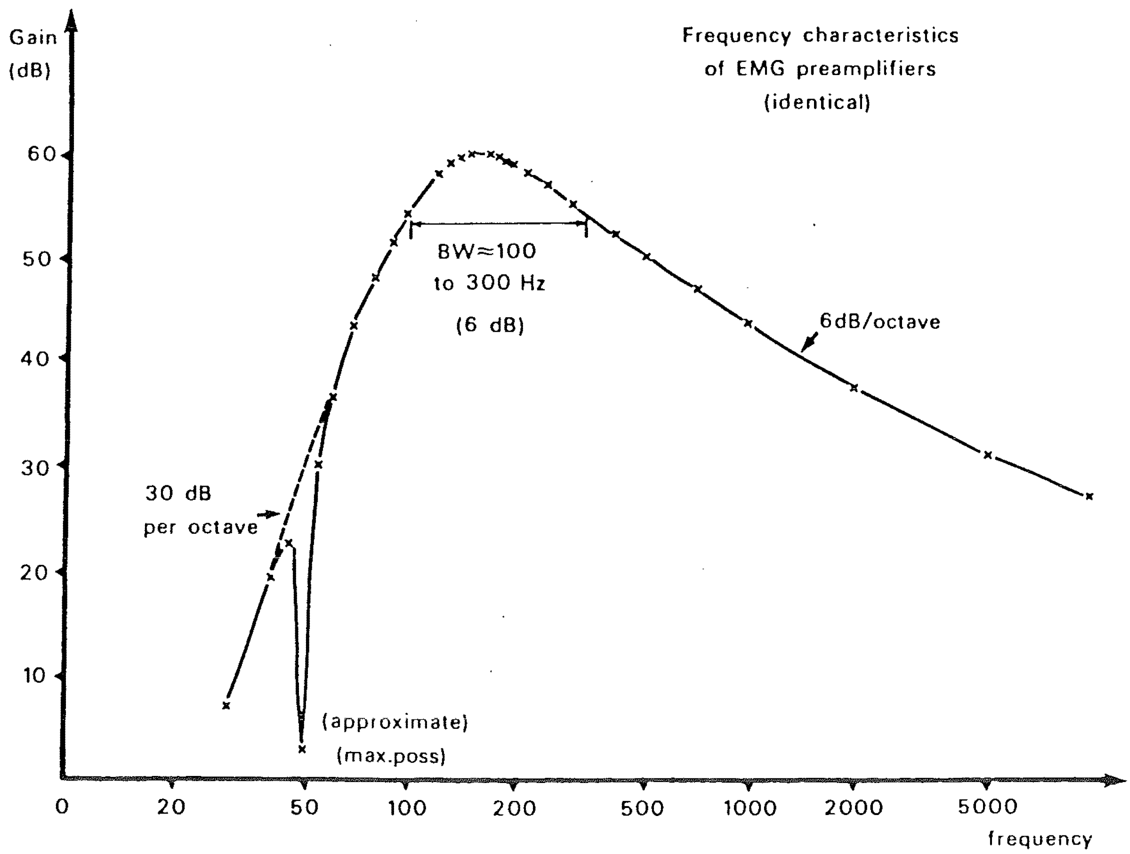
A bandwidth refers to a functional characteristic generated by a filter circuit that eliminates unwanted frequencies and passes the desired frequencies. Most of the electrical activity of muscles fall in the 30-100 H2 band and frequencies above 200 Hz contribute little to the total voltage.

output over that time interval. Averages could be read without affecting other functions of the unit.

Audio-feedback was an analogue tone, the frequency of which was proportional to the voltage indicated on the meter. The higher the voltage (i.e. continuous average EMG level) the higher the tone frequency. In this study, feedback was given of the average of the two channels together. Sensitivity was set at mid-range.

A criterion of one microvolt indicating relaxation was based on clinical judgement using this equipment and on literature (Peffer 1979). Patients averaging readings less than 1 microvolt over time consistently reported subjective sensations of relaxation. The components between 100-1000 Hz determine the wave form of the spike potentials at "low levels of tension". Therefore, it appears that where 60Hz EEG and EKG artifacts are not paramount, a 30Hz-1000Hz bandwidth would be ideal. In cases when any or all of those artifacts were present to any significant degree, a fairly sharp high-pass filter section with a cutoff frequency near 100 Hz had been found to minimise the effect of those artifacts. The cut-off above 1000 Hz could comfortably be 6dB per octave.(Armstrong, 1978, Peffer, 1979.)(see graph 1.)

GRAPH 1



Gain
(dB)
60
50
40
30
20
10
Frequency characteristics
of EMG preamplifiers
(identical)
BW≈100
to 300 Hz
(6 dB)
6dB/octave
30 dB
per octave
(approximate)
(max.poss)
0
20
50
100
200
500
1000
2000
5000
frequency

III.3.2 ELECTRODE PLACEMENT

Surface electrodes were used, (Hewlett Packard 9301-0240).

FOREHEAD MEASURE

The two recording electrodes were placed 1" above each eyebrow on the forehead noting that the spread of the electrodes would record a global measure of EMG, rather than a specific measure of frontalis muscle. A ground electrode was placed between these active electrodes.

ABDOMINAL MEASURE

The two recording electrodes were placed on the left and right belly of the rectus abdominis muscle, 10 cms above the umbilicus approximately, a position chosen to avoid dressings. No further ground electrode was required. (refer to Plate 1)

PLATE 1. Electrode Placement and EMG Equipment.

III.3.3 EMG DATA COLLECTION

Measures of EMG were taken on the two muscle sites simultaneously each minute for 20 minutes on the day prior to surgery, and on the first three post-operative days. The patient was usually in a half-lying position with three pillows supporting the back. Occasionally a patient would be lying flat because of low blood pressure. Days will be referred to as follows:

Day 0 - pre-operative day

Day 1 - first post-operative day

Day 2 - second post-operative day

Day 3 - third post-operative day

III.4 DISTENSION MEASURE.

Measurements were taken between the left and right anterior, superior iliac spines, and between each spine and the umbilicus each day. A distension score was calculated by taking the greatest difference on any of the post-operative days and day 0, expressing this difference as a function of the total measure at that sight on Day 0. This score was multiplied by 100, and 40 was added to remove negative values. This could not be regarded reliably, as a measure of distension, as both removal of fibroids and starvation lead to a shrunken abdomen.

III.5 PSYCHOLOGICAL TESTS

1. Demographic data was collected by questionnaire, Day 0.
2. Illness Behaviour Questionnaire ,Day 0. (IBQ)
3. State - Trait Inventory:

   A-State (STAI-X1) Day 0, and retested, Day 3.

   A-Trait (STAI-X2) Day 3.
4. Self-Rating Depression Scale - Zung. Day 3 (SDS)
5. Eysenck Personality Inventory Day 3 (EPI)
6. McGill Pain Questionnaire

   (adapted, following Leavitt, 1978) Day 3.
7. Questionnaire for patient to express her reaction to the study, Day 3.

These questionnaires were arranged in a format that allowed computer marking. The adjectives in the McGill Pain Questionnaire were randomly ordered on each questionnaire to avoid order effect. (see Appendix 1 for copies of test material)

III.6 DEPENDENT VARIABLE DATA COLLECTION

1. The "pain analogue scale" was a line 10 cms long, marked "no pain" at one end "worst pain you have ever felt". Patients made a pencil mark on the line to indicate the amount of pain being experienced at that moment. Nursing staff collected this information three times daily, when taking

temperatures, on the three post-operative days.

2. Analgesic data was collected from patient medical charts, and totalled and expressed as morphine equivalents.

III.7 PROCEDURE SUMMARY

Each patient was seen individually prior to surgery which was usually the day of admission. The research programme was described and her consent to participate obtained. The pre-operative tests were administered.

Patients in both the "feedback" and "no feedback" groups had the EMG equipment explained and demonstrated to them, electrodes were sited and measurements taken over 20 minutes, with brief instruction on relaxation being given within the first minute; e.g. let the bed take your weight, breathe quietly, feel your body resting. The auditory analogue tone which gave information from both muscle groups, was heard by the feedback group during this 20-minute period.

Each day, a graph was drawn of EMG over time for each muscle group and was shown and explained to the patient who usually showed interest in her performance (Plate 2 shows one graph of a patient who relaxed during a session, and one graph of a tense subject.)

On the three days after surgery the 20-minute relaxation sessions were repeated. On the final day the patients filled in the remaining questionnaires. They were given a further brief questionnaire to enable them to express their reaction to the programme.

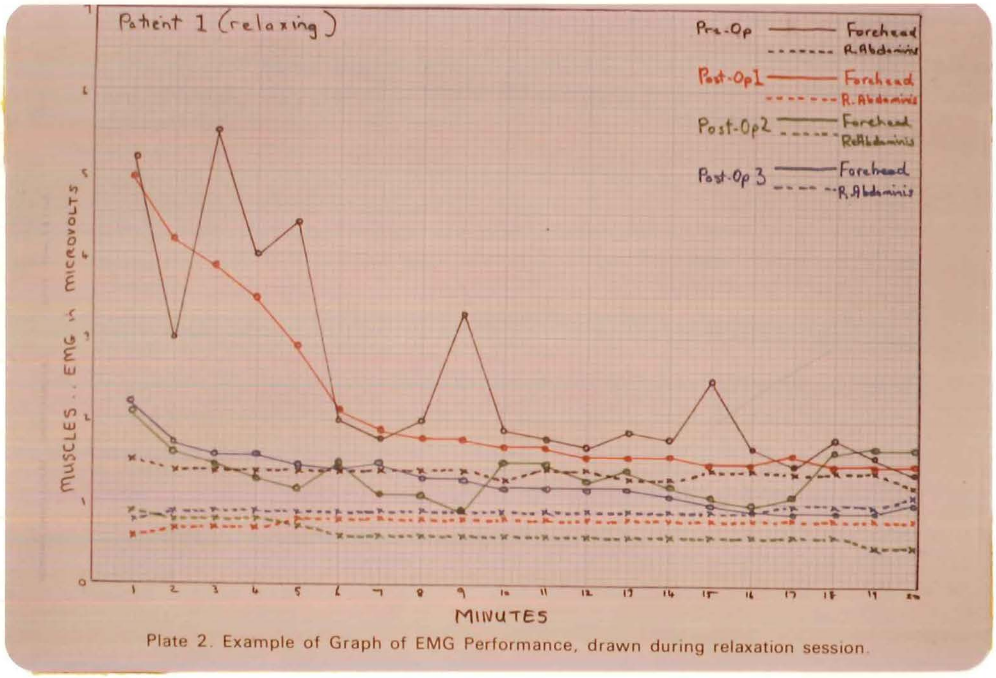


Plate 2. Example of Graph of EMG Performance, drawn during relaxation session.

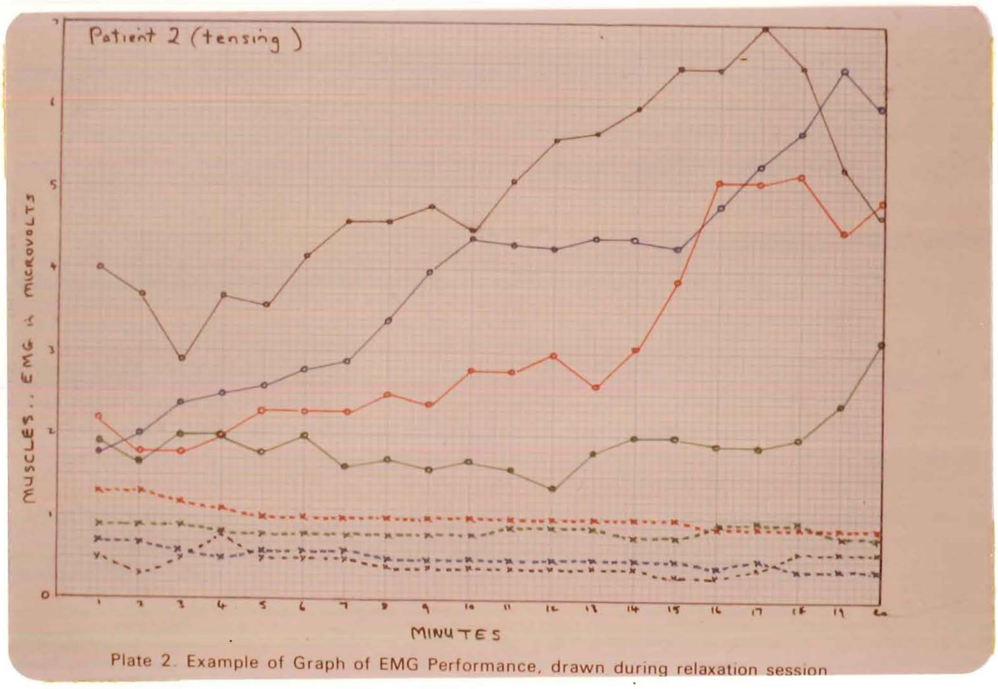


Plate 2. Example of Graph of EMG Performance, drawn during relaxation session.

PLATE 2. Examples of Graphs of EMG Performance.

IV RESULTS

IV. 1. ORDER OF ANALYSIS

A brief synopsis of the findings in each stage of the analysis is given to demonstrate the logical development of the analysis.

A Descriptive Analysis was made across all subjects to show that the control and experimental subjects came from the same population. Differences between groups of morphine usage and pain reports were identified.

Analyses of Variance of EMG Data showed the different action of the muscle groups and a decrease in EMG during training sessions, with feedback being significant in interactions.

Discriminant Function Analyses were used to identify those variables that could discriminate muscle activity and the ability to relax. The scales of the Illness Behaviour Questionnaire were used to discriminate low and high morphine users.

Factor Analysis of the McGill Adjective List identified a principle factor of emotional disturbance and its factor score coefficients allowed calculation of a further outcome variable.

Pearson's Correlations demonstrated relationships between dependent and independent variables, first across all subjects and then across experimental subjects only.

Multiple Regression Analyses were calculated to predict variance in the dependent variables.

IV. 2. DESCRIPTIVE ANALYSIS

IV. 2.1. Psychological tests and questionnaires were marked, using a computer programme developed by Dr. J.E. Wells (appendix 2).

IV. 2.2. Demographic data are shown in Table 1. Patients having the abdominal procedure were younger than patients having a vaginal hysterectomy, using the standard error of the difference to test significance. *

TABLE I: DEMOGRAPHIC DATA

	Experimental		Control	
	Abdominal	Vaginal	Abdominal	Vaginal
N	30	19	16	8
Age Mean	39.23	49.37	37.37	45.62
SD	7.02	8.84	7.1	9.9
% Married	80	74	50	88
% first surgery	30	47	36	38
% pain lead to decision/surgery	37	16	31	13

IV. 2.3. Psychological test results are shown in Table 2. There were no differences between the scores of the experimental subjects and the control subjects, using the standard error of the difference between means to test for statistical significance.*

---

* Formulae used:

standard error of the difference = $\left(\frac{n_1 s_1^2 + n_2 s_2^2}{n_1 n_2}\right)^{\frac{1}{2}}$;

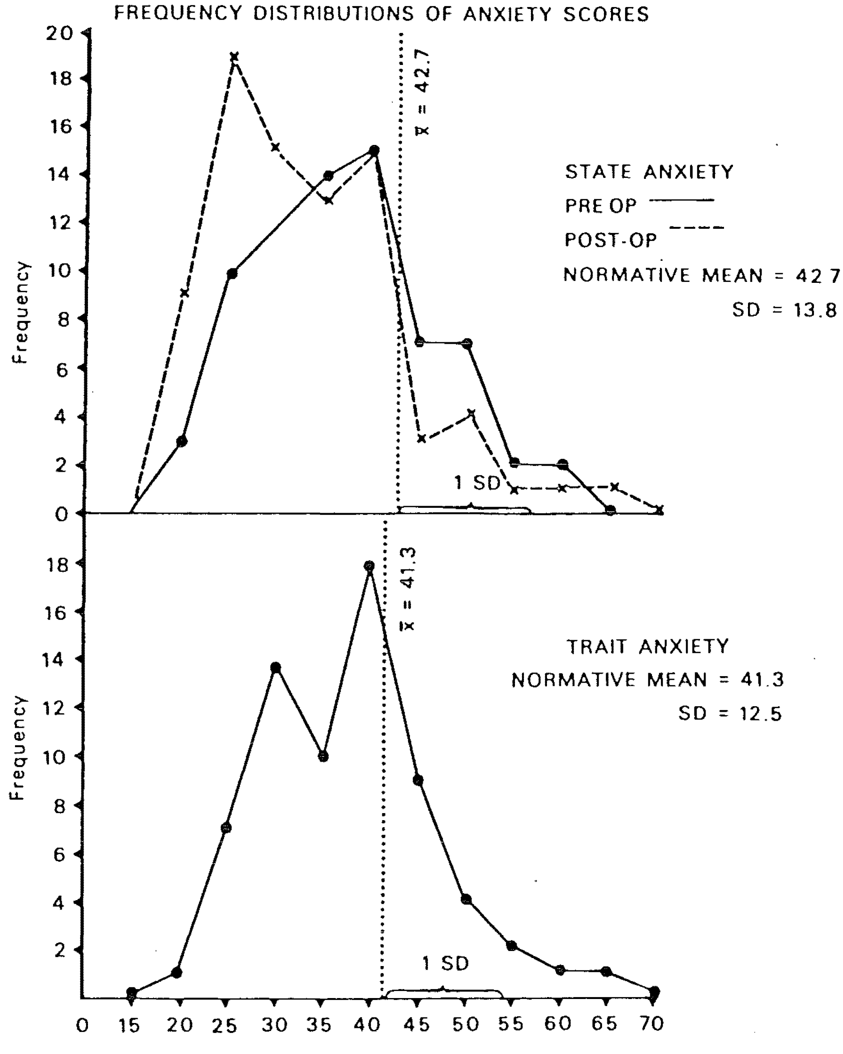
$\frac{\bar{X}_1 - \bar{X}_2}{\text{Std error}}$; function (Z) from tables; $p = 1 - 2\,(f\,(Z))$.

TABLE 2: PSYCHOLOGICAL TESTS

	Experimental		Control	
	Abdominal	Vaginal	Abdominal	Vaginal
N	30	19	16	8
STAI-XI, pre-op;				
mean	39.34	35.58	36.31	39.87
SD	9.26	9.4	8.7	12.5
STAI-XI, post-op;				
mean	35.47	36.63	30.0	32.0
SD	9.22	10.38	6.9	6.4
STAI-X2, mean	39.67	41.79	31.87	36.5
SD	9.67	9.9	6.4	7.7
AIB (Pilowsky)				
mean	44.67	52.0	51.25	57.0
SD	15.27	9.22	8.29	12.6
Depression (Zung)				
mean	47.3	50.42	43.37	44.5
SD	9.4	7.8	7.2	5.5
EPI, Extraversion				
mean	9.83	9.1	11.25	11.87
SD	3.83	2.5	3.66	3.94
Neuroticism				
mean	10.1	12.58	6.5	9.62
SD	5.1	4.9	4.38	5.01
Lie mean	4.73	4.2	4.12	4.0
SD	1.8	1.4	1.96	1.31

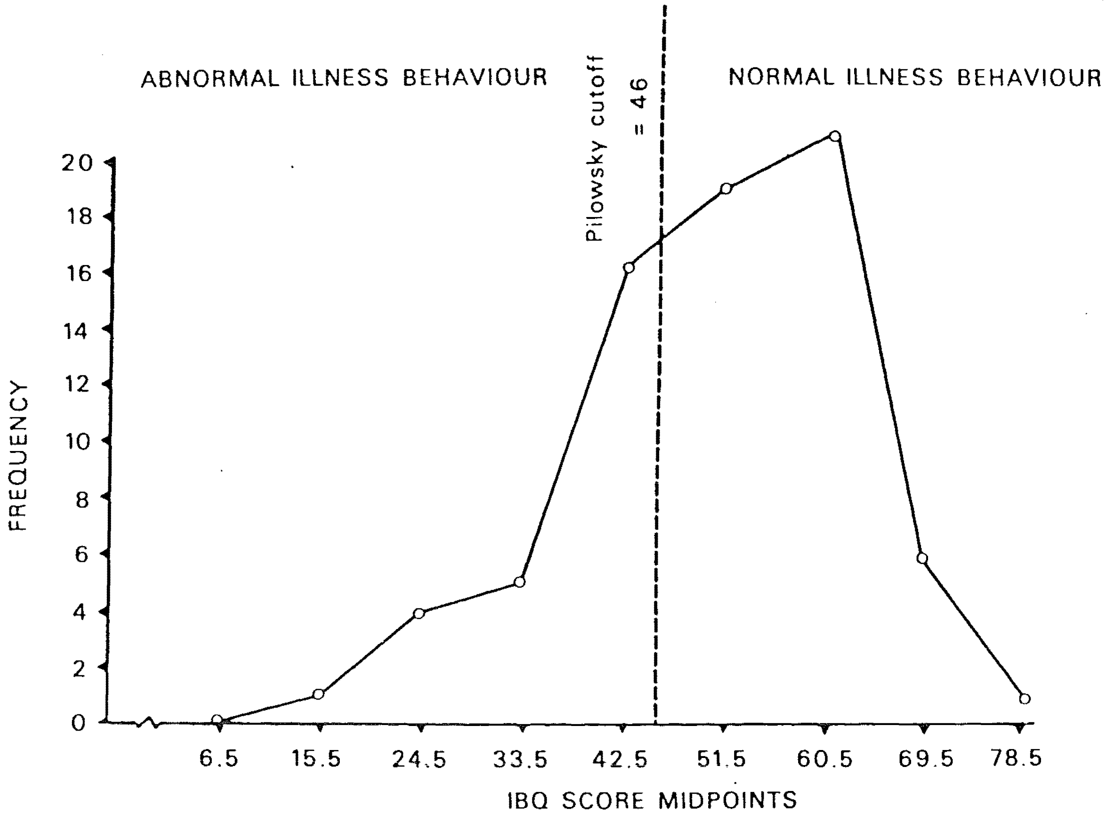
GRAPH 2

FREQUENCY DISTRIBUTIONS OF ANXIETY SCORES



GRAPH 3

FREQUENCY POLYGON OF PILOWSKY'S ABNORMAL ILLNESS BEHAVIOUR SCORES (IBQ)



IV. 2.4. Anxiety score frequency distributions are shown on graph 2, and the reduction of state anxiety post-operatively was noted. Normative means and standard deviations from the Manual for the State-Trait Anxiety Inventory (p.8) for "general medical and surgical patients with a mean age of 55 in the southern eastern United States" are marked. Patients in the current study had a lower mean age of 42 years. The scores of all but two subjects with state anxiety and four subjects with trait anxiety were within normal boundaries. State and trait anxiety were highly correlated. (See scattergram, appendix 7)

IV. 2.5. The Illness Behaviour Questionnaire (Pilowsky 1978) was developed to identify patients manifesting abnormal illness behaviour. A discriminant function was derived from scores relating to disease conviction, somatic focusing, denial and irritability. A transformed version of this function which generates a range of scores from 0-88 is as follows, (corrected to four decimal places):-

10 x scale 3 - 4.0172 x scale 2 - 4.116 x scale 6 - 2.649 x scale 7 + 13.5384, plus an additional 71.465 to achieve zero origin.

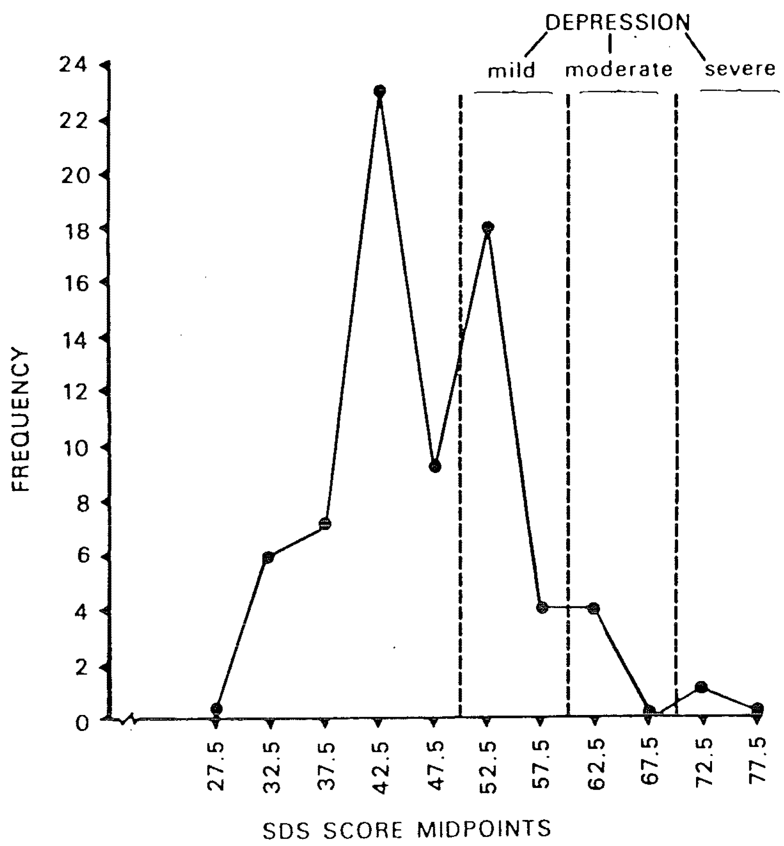
After communication with Pilowsky (Moon, 1981, Pilowsky 1981) it was agreed that a mistake had been made in this final figure which should have read, "plus an additional 44.388 to achieve zero origin."

In this study a discriminant function score was obtained for each patient. Pilowsky (1981) recommended a cutting score of 46 for this corrected transofrmed equation, i.e., scores below 46 indicated the presence of abnormal illness behaviour.

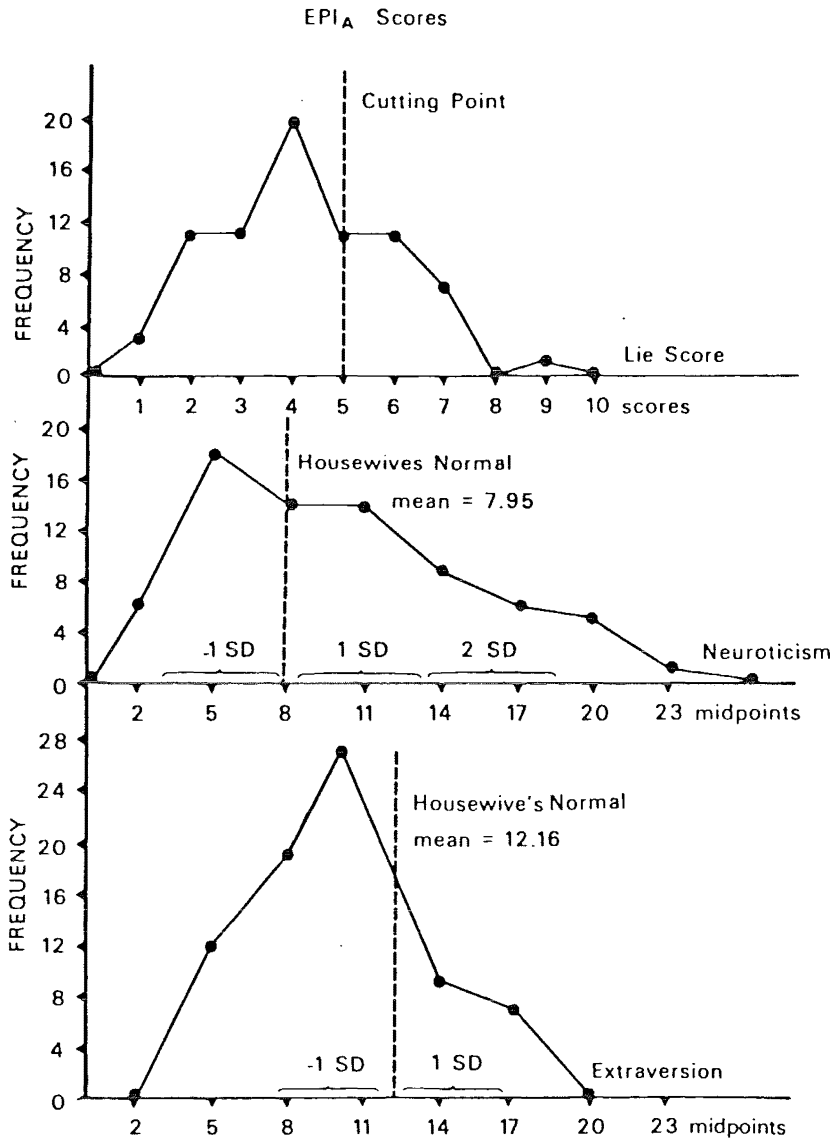
The frequency polygon (graph 3) of the distribution of these scores shows that 26 subjects (36%) obtained scores less than 46. The experimental abdominal group of subjects obtained a mean of 44.7 indicating the prevalence of illness behaviour in this group.

GRAPH 4

FREQUENCY POLYGON OF SDS SCORES – ZUNG DERESSION



GRAPH 5


EPI$_A$ Scores
Cutting Point
FREQUENCY
20
16
12
8
4
0
Lie Score
1 2 3 4 5 6 7 8 9 10 scores
Housewives Normal
mean = 7.95
FREQUENCY
20
16
12
8
4
0
-1 SD
1 SD
2 SD
Neuroticism
2 5 8 11 14 17 20 23 midpoints
28
24
20
16
12
8
4
0
FREQUENCY
Housewive's Normal
mean = 12.16
-1 SD
1 SD
Extraversion
2 5 8 11 14 17 20 23 midpoints

IV. 2.6. Depression scores were measured on the Zung Self-Rating Scale. Zung (1967) said that patients with mild to moderate amounts of depression had scores greater than or equal to 50, patients with moderate to severe depression had scores greater than or equal to 60, and patients with severe depression had scores greater than 70.

Using these criteria, inspection of the frequency polygon of SDS Scores (graph 4) showed that 22 patients had mild to moderate depression, 4 had moderate to severe depression and 1 had severe depression, i.e., 37% of subjects were depressed on the third day post-operatively.

IV. 2.7. Eysenck Personality Inventory score distributions are shown in graph 5. Both extroversion and neuroticism scores were skewed towards lower scores. Eysenck (1964) gave the following as normal scores for EPI, version A.

	Age	Extroversion	Neuroticism
Housewives			
Mean	42.16	12.167	7.958
SD	12.5	4.752	5.393
Normal Population			
Mean	27.45	12.07	9.065
SD	12.0	4.37	4.783

The population being studied was more akin to housewives by age and sex.

A cut-off of 4 or 5 for the Lie score was given by Eysenck. 30 subjects scores that were greater than or equal to 5.

IV. 2.8. Current and past pain experiences were described and location of pain was indicated and these are shown in Table 3. The control abdominal subjects expressed a greater degree of "pain at its worst." The vaginal patients, both experimental and control, saw past pain experience as having been more severe than did the abdominal groups. Relatively, they appeared to have experienced less pain with this operation than they remembered having experienced previously.

Location of pain would be expected in the pelvis. It was of interest that many patients did not feel pain at sites where reasonably it could be expected, viz., abdomen and sacrum.

TABLE 3: PAIN EXPERIENCE AND LOCATION

		Experimental		Control	
		Abdominal	Vaginal	Abdominal	Vaginal
	N	30	19	16	8
current experience	(Pain Now	1.7	1.6	1.25	1.6
	(Pain at Worst	3.0	2.7	3.4	2.9
	(Pain at least	1.3	1.4	1.25	1.4
past experience	(Worst toothache	2.8	3.7	3.1	3.7
	(Worst headache	3.2	3.7	3.1	3.9
	(Worst stomachache	3.4	2.9	3.1	2.7
Location of Pain					
Pelvis, in % of Ss.		73%	95%	94%	88%
Abdomen		46%	16%	19%	25%
Sacrum		46%	53%	31%	50%
Buttocks		30%	5%	50%	38%
Legs		3%	0%	6%	13%
Chest		17%	5%	0%	0%
Neck		10%	5%	12%	0%
Other (mostly relating to injection and transfusion sites)		10%	5%	6%	25%

IV. 2.9. Morphine scores (Table 4) were calculated as the equivalent in grams of morphine administered to patients (Appendix 5). Adjustments are made for body weight on the scores for Day 1 and for the total across the 3 post-operative days. As there was controversy as to whether doctors adjusted prescribed doses for body weight, in further analyses both "total morphine" and "total morphine/weight" were considered.

TABLE 4: MORPHINE SCORES (Equivalent grams of morphine)

		Experimental		Control	
		Abdominal	Vaginal	Abdominal	Vaginal
Morphine, Day 1	Mean	32.56	21.42	36.19	28.5
	SD	10.2	11.5	11.87	8.4
Morphine, Day 2	Mean	10.53	11.79	19.62	19.5
	SD	7.5	10.8	10.5	13.4
Morphine, Day 3	Mean	1.8	0	1.25	0
	SD	5.9	0	5.0	0
Weight (Kgms)	Mean	67.4	66.6	60.81	62.78
	SD	21.4	15.7	8.56	9.27
Day 1/70 kgms	Mean	33.86	22.52	41.65	31.78
Total Morphine	Mean	44.9	33.21	57.06	48.00
	SD	15.6	17.5	19.6	17.54
Total Morphine/ 70 kgms	Mean	48.87	33.37	66.44	55.63
	SD	19.2	18.76	23.64	23.6

		Feedback	No Feedback	Control
Abdominal	Mean	49.5	50.9	66.7
	SD	18.1	19.3	23.6
Vaginal	Mean	41.8	30.3	55.6
	SD	15.1	18.5	23.6

		Abdominal	Vaginal
Total Subjects	Mean	55.9	41
	SD	21.6	27.7

TABLE 5:

MORPHINE RESULTS: ANALYSIS OF DIFFERENCE BETWEEN THE MEANS.
(total equivalent morphine in grams/70 kgms body weight)

	Groups	Significance of p.
Abdominal	Experimental, Control No feedback, Control Feedback, Control Feedback, No Feedback	.0066 .0464 .0204 NS
Vaginal	Experimental, Control No feedback, Control Feedback, Control Feedback, No Feedback	.0094 .0108 NS NS
Experimental Control Total	Abdominal, Vaginal Abdominal, Vaginal Abdominal, Vaginal	.0052 NS .0052

In the abdominal surgery group, control subjects had more morphine than experimental subjects. This occurred in both feedback and no-feedback conditions but there was no difference between these experimental groups.

The control subjects had more morphine than the experimental subjects after the vaginal surgery also. This difference was between the no-feedback and the control subjects, and again there was no difference between the two experimental groups.

The abdominal subjects had more morphine than the vaginal subjects in the experimental condition but no difference showed in the control group.

Therefore, there is an experimental and surgical effect, but no feedback effect in total morphine administered to patients.

It was noted that patients having the abdominal surgical procedure were younger than those having the vaginal procedure. Therefore, the difference between surgical groups of total morphine usage was examined to see if the effect was due to age rather than surgery (Table 6). There was a significant correlation between age and morphine in the abdominal group but not in the vaginal group.

TABLE 6:

CORRELATION OF AGE AND MORPHINE/SURGICAL GROUPS

		Abdominal	Vaginal
Age	Mean	38.82	46.29
	SD	6.88	12.73
Morphine	Mean	48.02	38.17
	SD	16.8	18.34
N		46	24
r		0.455	0.099
p, (n-2)df		0.01	NS

IV. 2.10. Pain Analogue Scores were expected from each subject 3 times daily for 3 days. Much of this data was missing. Where a minimum of 4 scores were obtained the mean was taken and an arcsin transformation used to obtain an index for each patient. This variable was unreliable but was inspected for interest.

Analysis of the differences between the means (Table 7) showed no differences between the total experimental and control subjects, or between these groups within abdominal surgery. However, the vaginal subjects showed higher scores for the control subjects than for the experimental subjects ($p = .01$).

These results could only be treated with caution.

TABLE 7:

PAIN ANALOGUE SCORES

		Experimental	Control
Abdominal	Mean	3.23	2.98
	SD	1.75	1.3
	N	30	15
Vaginal	Mean	2.48	3.68
	SD	1.61	0.75
	N	15	6
Total	Mean	2.98	3.17
	SD	1.73	1.2
	N	45	21

IV. 2.11. Summary of Descriptive Analysis

In a descriptive analysis across all subjects, experimental and control subjects came from the same population as defined by the psychological tests. Patients having the abdominal surgical procedure were younger than those having the vaginal procedure. Distributions showed the presence of abnormal illness behaviour in 36% of the population, and 37% of patients were depressed on the third day after the operation.

The control subjects had more morphine than the experimental subjects. The abdominal surgical patients had more morphine than the vaginal group and within the former, younger patients had more morphine than the older patients.

In the vaginal surgical group, the experimental subjects reported less pain than the control subjects but this data was unreliable.

IV. 3. ANALYSES OF VARIANCE

IV. 3.1. The EMG data from the two muscle sites was examined using analysis of variance. Difficulty was experienced in obtaining a suitable programme because of the large number of measures, the unequal numbers of subjects in the different conditions, subplots in which subjects were nested under both the operation and feedback conditions and the need to use replications on account of the limitations imposed by memory on the computer system being used. The data was analysed, therefore, using a series of ANOVAs.*

The following are the factors used in the ANOVAs.

Factor	Levels of Factor	Abbreviation	Effect	Comment
Feedback	Feedback; No feedback	F	Fixed	
Operation Site	Abdominal, Vaginal	O	Fixed	
Subjects		S	Random	Nested under F, O
Day	0, 1, 2, 3	D	Fixed	
Muscle site	forehead, rectus abdominis	M	Fixed	
Time	1-20 minutes	T	Fixed	
		R		Replications

---

* The first ANOVA used the programme Teddybear, and was run on the Burroughs B6718 computer, University of Canterbury. Further ANOVAs used a programme developed by J. Ogilvie, University of Toronto, modified by J.E. Wells, biostatistician, Otago Medical School. It was available only on the Otago University computer, PDP-11/70, at the Clinical School, Christchurch Hospital. This programme computed sums of squares; the error terms, mean squares and F-ratios were calculated manually. See Appendix 4 for ANOVA tables.

IV. 3.2. Descriptions of ANOVAS

Because of uneven numbers of subjects in different conditions, for the initial runs, the number was reduced to 9 in each condition. Three were eliminated because of missing data due to incidents unrelated to this study (interruption by a surgeon, machine problems in one channel). Of those subjects remaining, 9 were selected randomly for each cell, as follows:

	N in Study		Missing data eliminated		Random Select ANOVAS 1-4		Totals ANOVAS 5-6
	Abd.	Vag.	Abd.	Vag.	Abd.	Vag.	Σ Abd.,Vag.
Feedback	16	9	14	9	9	9	23
No Feedback	14	10	13	10	9	9	23
Control	16	8	-	-	-	-	-

ANOVA 1.

On pre-operative data only, i.e. on Day 0.

design: O x F x S x M x T

2 x 2 x 9 x 2 x 20

ANOVA 2.

Included Days as a factor and used time as a replication.

design: O x F x S x D x M/R

2 x 2 x 9 x 4 x 2/20

ANOVA 3.

Looked at forehead muscle site alone.

design: O x F x S x D x T

2 x 2 x 9 x 4 x 20

ANOVA 4.

Looked at the rectus abdominis muscle separately.

design: O x F x S x D x T

2 x 2 x 9 x 4 x 20

ANOVA 5.

As operation site had not been significant subjects were put into 2 groups according to the feedback condition. Those subjects previously excluded randomly were included again, giving two groups each of 23 subjects. Only the forehead muscle site was used. Shortage of memory space on the PDP-11/70 meant that replications within cells had to be used (EMG was averaged over 2 minutes with 10 replications).

design: F x S x D x T/R

2 x 23 x 4 x 10/2

ANOVA 6.

Day 1 was eliminated because of morphine confounding. Therefore factor Day had only three levels, 0, 2, 3. Forehead muscle site only was in the analysis. No replications were required.

design: F x S x D x T

2 x 23 x 3 x 20

This progression of ANOVAS allowed factors to be altered and eliminated, and the power of the tests gradually was increased.

IV. 3.3. <u>Summary of ANOVA results</u>

The detailed ANOVA tables are given in Appendix 4. Table 8 shows those main effects and interactions that were significant ($p \leq 0.05$).

Examination of Table 8 demonstrates the logic of the order of the ANOVAs. When it was shown that the muscle action of the forehead and abdominal muscle sites was different (ANOVAs 1, 2), each muscle site was examined individually (ANOVAs 3,4). Most activity in the rectus abdominis muscle was less than 1 microvolt which was the criterion used in this study to indicate relaxation of a muscle. Therefore, no further study of the rectus abdominis muscle was made.

Whether or not the patient had had the abdominal or the vaginal procedure for her hysterectomy made no difference, so Operation was eliminated as a factor. This allowed the inclusion of more subjects, resulting in more power in the analysis.

From clinical ohservation it appeared that the medication given on Day 1 affected patient behaviour as many were difficult to rouse. Therefore, the final ANOVA looked at muscle activity with Day 1 eliminated.

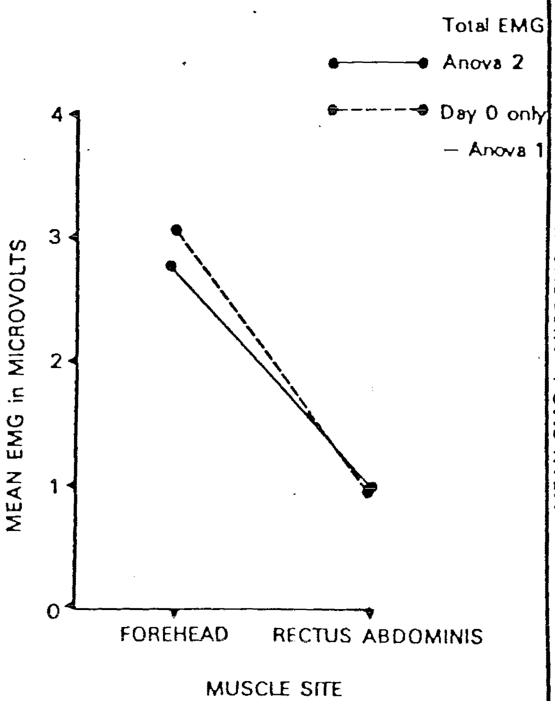
TABLE 8: SUMMARY OF ANOVAS

	ANOVAS					
Main Effects	1	2	3	4	5	6
M	***	***	/	/	/	/
D	/	**	**		*	
T		/	***	***	**	***
Interactions						
FM	**		/	/	/	/
MD	/	*	/	/	/	/
FT		/			*	**
DT	/	/	**		**	***
FOT		/		**	/	/
FMT	***	/	/	/	/	/
FDT	/	/	**		**	***

Key	
***	F ratio $\leq$ 0.001 significance
**	F ratio $\leq$ 0.01 significance
*	F ratio $\leq$ 0.05 significance
/	Not relevant to specific ANOVA.

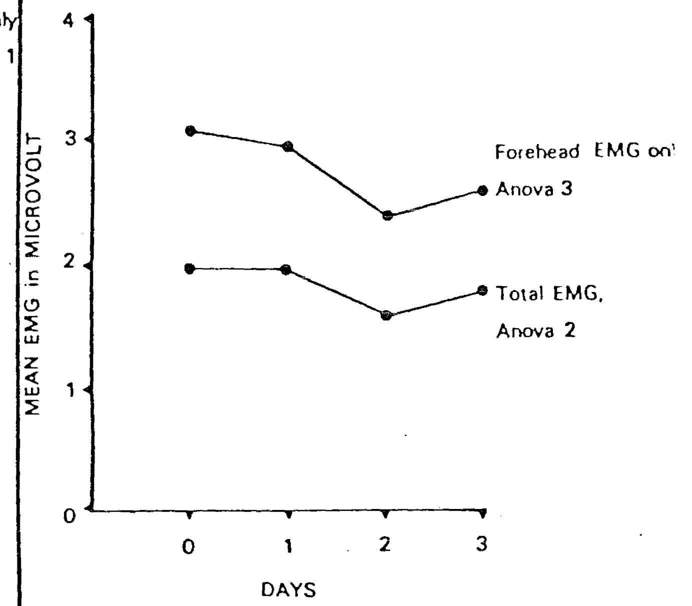
GRAPH 6

MUSCLE SITE, MAIN EFFECT
significance .0001



GRAPH 7

DAYS - MAIN EFFECT
.01 significance



IV. 3.4 Discussion of Results of Analyses of Variance on EMG Data.

The forehead muscle area and the rectus abdominis muscle acted differently. The average forehead activity on the day before surgery was 3.07 μv and over the four days the mean was 2.717 μv. The mean activity for the rectus abdominis muscle was less than the criterion for relaxation of 1 μv, being 0.9 μv on Day 0 and 0.94 μv across the four days (Graph 6).

Therefore, when the patient was resting with the body fully supported in a half-lying position the rectus abdominis muscle was showing normal behaviour. Those subjects whose abdominal muscle activity was greater than the criterion were examined in section IV. 4.3.

The forehead muscles did not relax. Their activity was examined further in relation to psychological variables and pain behaviours. (IV. 4.1, IV. 6.3, IV. 6.6, IV. 7.2)

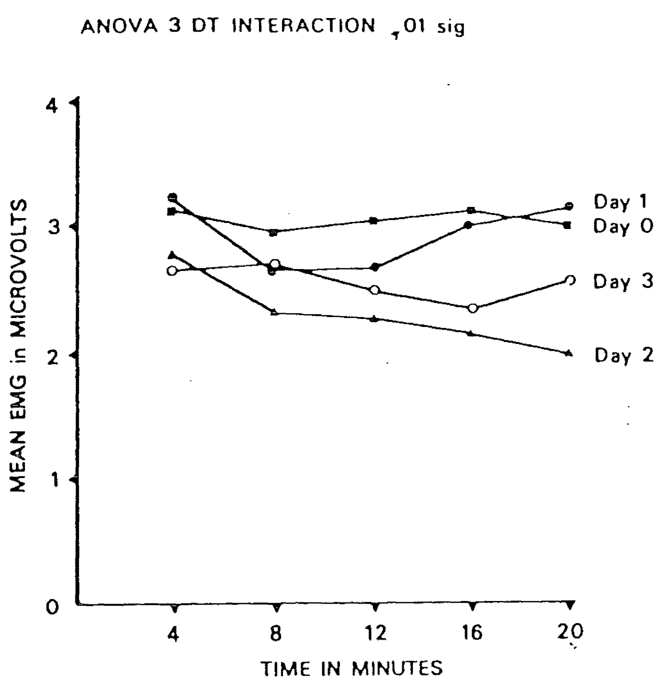
Muscle activity was not the same on each day. (ANOVAs 2, 3) (graph 7). This effect was due to the forehead muscle activity (ANOVA 5) and not the rectus abdominis muscle. (ANOVA 4). When data from the day immediately following surgery was removed from the analysis (ANOVA 6) this effect disappeared. Therefore, it was concluded that muscle activity in the forehead was different on Day 1 than on the other days.

Muscle activity lessened over the 20 minutes of the practice sessions (ANOVAS 5, 6), and this effect was seen in both muscle groups (ANOVAs 3, 4).*

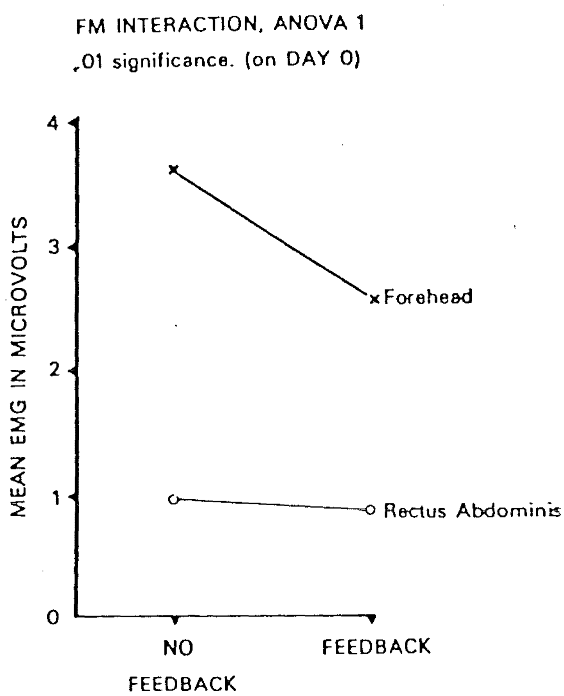
---

* ANOVA 1, using the Teddybear Programme, gave additional information on the Time Factor. The 20 levels of that factor had different error variance such that Bartlett's Test m/c = 32.434, with a probability of p = 0.028; i.e. the standard deviations showed less variability as time went on.

GRAPH 8



GRAPH 9



The interaction between the effects of EMG changes over time on the different days are shown on Graph 8. On the first day there was little change over the 20 minutes (ANOVA 1) whereas on the 2nd and 3rd post-operative days the EMG decreased during the session. On the first day post-operatively the EMG decreased and then increased.

Auditory feedback of the analogue of the mean EMG activity from the two muscle sites was given to some subjects and it was predicted that those subjects would reduce muscle activity more effectively. The feedback had an effect on the forehead muscle but not on the rectus abdominis muscle which was already relaxed (Graph 9). Feedback over the 20 minutes was effective in the forehead muscle, particularly when the data from the first post-operative day was eliminated (ANOVA 6). Graph 10 shows that during the first 4 minutes there was little difference between the feed-back and no-feedback groups in the forehead EMG, but that over the next 12 minutes of the session the no-feedback group showed minimal EMG change, while the feedback group showed a steady decrease in muscle activity. Little change occurred in the last 4 minutes in either group. Thus, the two muscle groups behaved differently and the effect of the auditory feedback over the 20 minutes was different on both. (ANOVA 1, graph 11) Feedback appeared effective in helping the subject to reduce forehead muscle activity, but made no difference to the abdominal muscle activity.

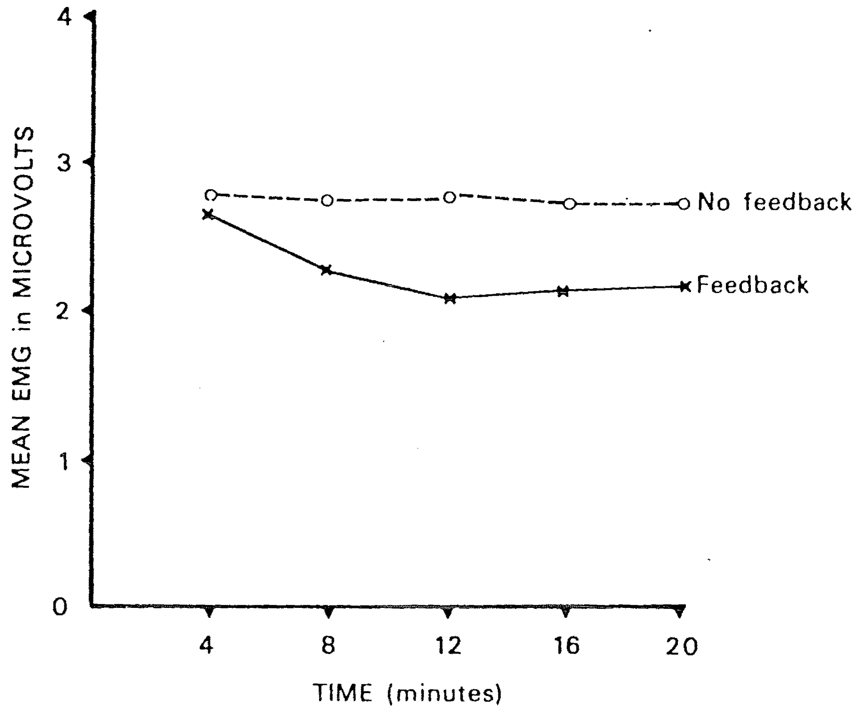
The feedback effect over the 20 minutes varied on the different days. Graph 12 shows that learning appeared to occur in the feedback group on the pre-operative session. The day after surgery feedback clearly had no effect, and on Days 2 and 3 there was decreasing activity in the forehead muscles (ANOVAS 3, 5, 6), with less difference between the feedback and no-feedback groups.

Feedback over the 20 minutes produced a different effect

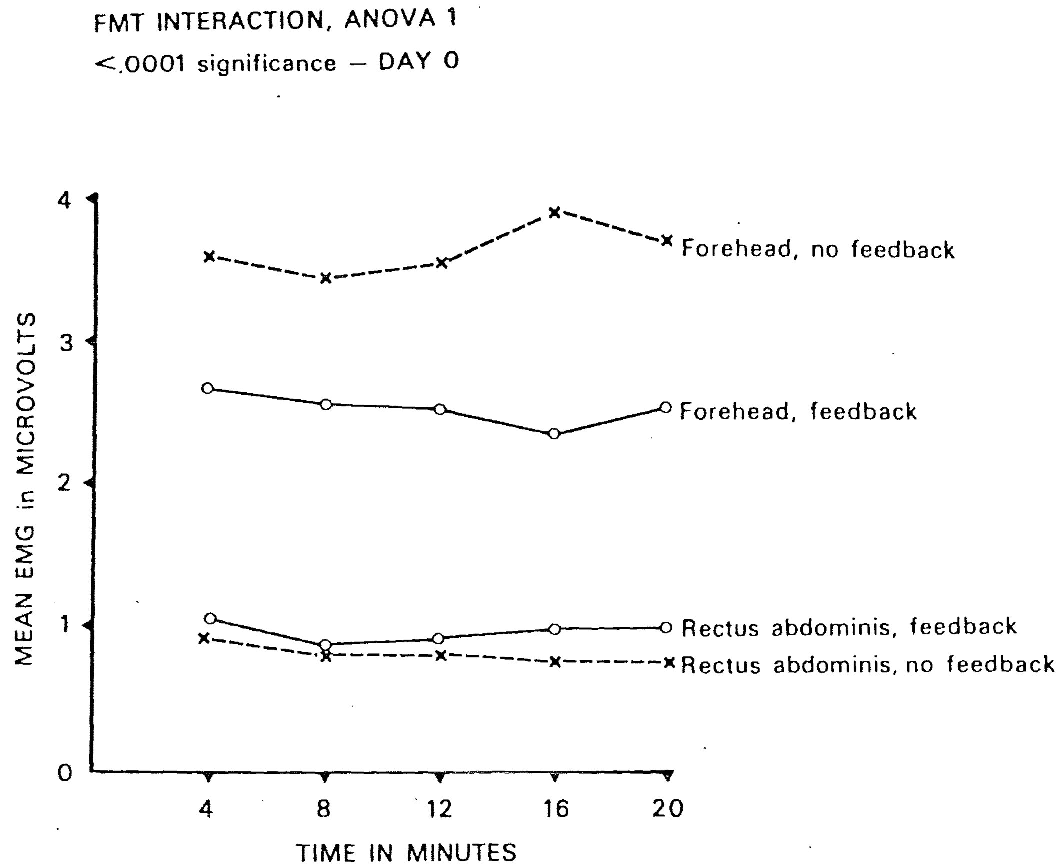
GRAPH 10

FT INTERACTION ANOVA 6

.01 significance

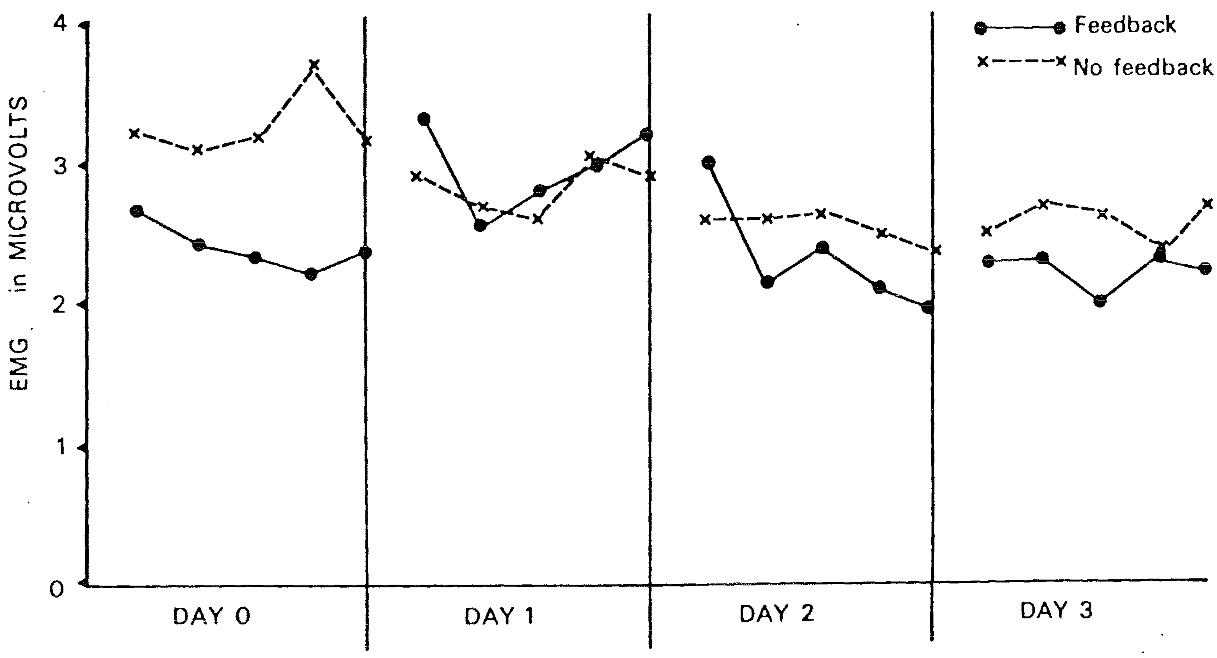


GRAPH 11


FMT INTERACTION, ANOVA 1
<.0001 significance – DAY 0
MEAN EMG in MICROVOLTS
4
3
2
1
0
4
8
12
16
20
TIME IN MINUTES
Forehead, no feedback
Forehead, feedback
Rectus abdominis, feedback
Rectus abdominis, no feedback

GRAPH 12

ANOVA 5 FDT INTERACTION Sig — .01

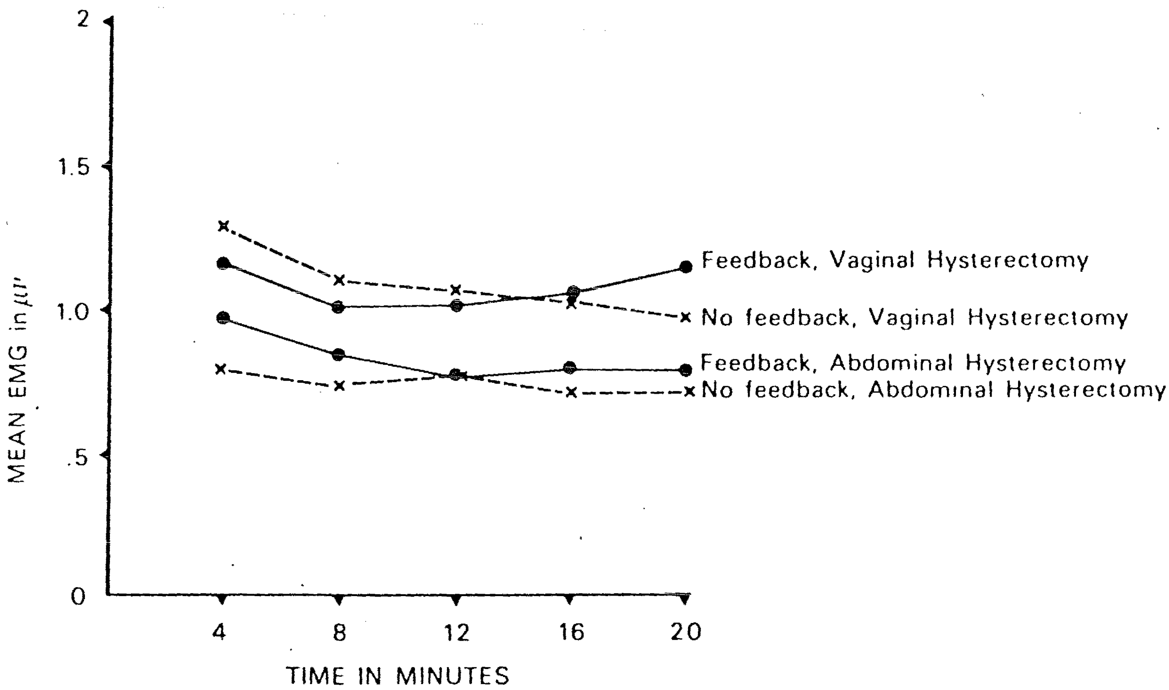


GRAPH 13

FOT INTERACTION in ANOVA 4

.01 significance

ON RECTUS ABDOMINIS MUSCLE



on the rectus abdominis muscle, depending on the type of surgery (ANOVA 4). The effect was small, as the mean EMG overall was below the criterion for relaxation, but it was noted that those subjects having the abdominal surgical procedure showed less EMG activity in the rectus abdominis muscle than those having the vaginal procedure. (Graph 13)

IV. 3.4. Summary of Results of EMG Data Analysis.

1. The forehead muscle group behaved differently from the rectus abdominis muscle.
2. The rectus abdominis muscle relaxed when the patient was resting.
3. Muscle activity decreased at both sites during the 20 minutes sessions.
4. Auditory feedback was effective in helping a subject to reduce forehead muscle activity.
5. Forehead muscle activity differed on the day immediately after surgery from other days.
6. Auditory feedback was not effective on the first post-operative day.
7. Auditory feedback had no effect on a subject's ability to reduce EMG activity in the rectus abdominis muscle, as that muscle was already relaxed.
8. Less EMG activity was measured in the rectus abdominis muscle in these patients having the abdominal hysterectomy than in those having the vaginal procedure.

IV. 4. DISCRIMINANT FUNCTION ANALYSES

IV. 4.1. Discrimination on Forehead EMG, Day 0.

A discriminant function analysis was used to establish which variables were effecting EMG levels. Low, medium and high muscle tension groups (Table 9) were the dependent variable, and the independent variables are shown in Table 10.

TABLE 9.

Group	Tension	Mean EMG	Number
1	Low	$< 2\mu v$	17
2	Moderate	$2\,\mu v$ - $\leq 3.5\,\mu v$	15
3	High	$> 3.5\ \mu v$	16
			48

TABLE 10.

Independent Variable	Abbreviation	Initial
Age	Age	A
State Anxiety, pre-operative, STAI-X1	State	S
Trait Anxiety, STAI-X2	Trait	T
Illness Behaviour, Pilowsky	AIBQ	I
Depression, Zung SRS	Depress	D
First Experience of Surgery	Firsurg	G
Pain as main sympton for Surgery	PainLS	P
Feedback in Experimental Condition	Feedback	F
Extraversion, EPI	Extraversion	E
Neuroticism, EPI	Neuroticism	N
Lie, EPI	Lie	L

The stepwise procedure was one in which variables were selected for entry into the analysis on the basis of their discriminatory power using Wilk's criterion. In this procedure the overall multivariate F-ratio for the test differences among the group centroids was calculated. An optional set of variables is selected by this method with the assumption that the stepwise procedure is an efficent way of approximately locating the best of the discriminatory variables.

The order of the variables in the analysis after the last step by Wilk 's lambda was Trait, Lie, Feedback, IBQ, Age, PainLS, Extraversion and State. These scales in the functions each contributed significantly ($p < 0.01$) to the differences between the 3 groups. The contribution of each was indicated by the weighting assigned to each scale, derived from the respective changes in Wilk's lambda as each scale was extracted. The variables Depress, Neuroticism and Firsurg did not have a significant effect and thus were not included in the discrimination.

Two standardized canonical discriminant functions were obtained, accounting for 73% of the variance ($p = 0.0001$) and 27% ($p = 0.04$) of the variance respectively.

Function 1:

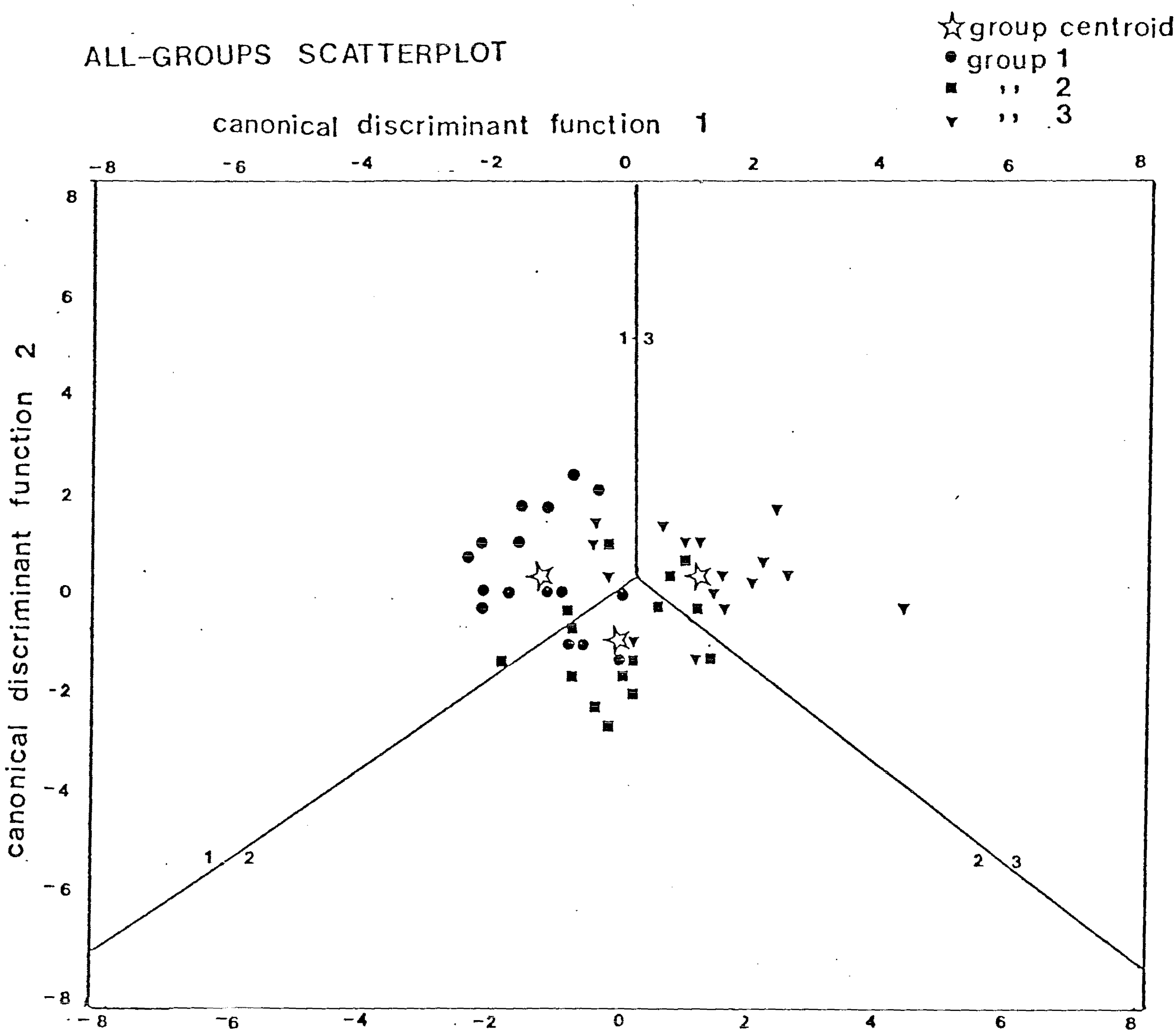
$.91T - .67F + .5I + .5P - .43E + .42L + .22S + .11A$

Function 2:

$.84L + .79A + .54P - .47S + .4E - .36I + .31F - .08T$

These functions correctly classified 68.75% of the subjects as belonging to low, moderate or high tension groups. Graph 14 shows the All-groups scatterplot, with the territorial map superimposed. A prediction of membership in adjacent groups was anticipated because of the manner in which the distribution of the EMG data was divided into 3 groups. Three members of group 3 that were falsely classified as group 1 were the only exceptions.

GRAPH 14



Discrimination on Forehead EMG, Day O.

A chi-squared calculation of the classification results was significant (p = 0.001).

Inspection of the group centroids and the territorial map showed that function 1 separated the three groups from each other, and function 2 separated the middle function from the other two. (Graph 14)

TABLE 11.

GROUP MEANS OF THE SIGNIFICANT VARIABLES/EMG.

	Groups/EMG		
	Low	Moderate	High
Trait	34.88	40.13	46.12
Lie	4.6	3.7	5.1
Feedback	.7	.4	.4
AIBQ	45.8	50.0	50.5
Age	43.7	41.06	45.31
PainLS	.18	.2	.37
Extraversion	10.5	9.0	9.3
State	34.6	40.0	41.1

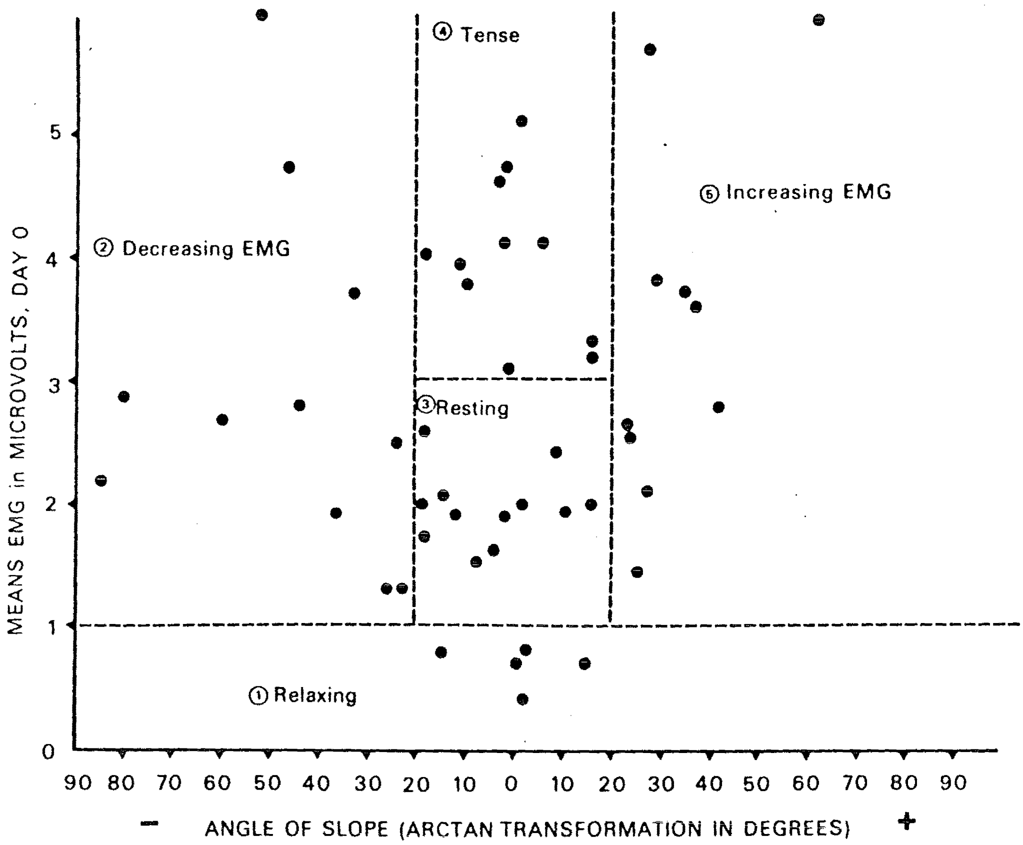
Table 12 shows the group means of the significant variables, which were examined together with the weightings of the variables in the functions. The effect of feedback was noted. Trait and State anxiety were greater in the high tension group. Illness behaviour means showed more illness behaviour in the low tension group. Age and Lie contributed to the second function which separated the middle group from the other two.

IV. 4.2. Discrimination on Relaxation

The regression values of forehead muscle activity on the pre-operative session were calculated and plotted on a scattergram. The mean rather than the intercept was chosen for

GRAPH 15

RELAXATION MEASURE



the Y-axis because it was more representative of the population as not all the regression equations had significant F-ratios. (Graph 15)

An arctan transformation of the slope value gave the "angle of slope" used on the Y-axis. This transformation drew in the extreme values and was useful as negative values indicated decreasing EMG or relaxation during a session and positive values indicated increasing EMG values over time.

Criteria used to place subjects in groups as an indication of "relaxation behaviour" are shown in Table 12.

TABLE 12.

Group	Criteria	Number
1. Relaxed	Mean $\leq$ 1μv	5
2. Decreasing EMG	Mean > 1μv, Slope >-20°	12
3. Resting, little change	Mean > 1μv, < 3μv Slope -20° to 20°	12
4. Tense, little change	Mean > 3μv, Slope -20° to 20°	10
5. Increasing EMG	Mean > 1μv, Slope >+ 20°	10
		49 subjects

This relaxation variable differed from the previous discriminant on EMG as it took into account the behaviour of the subject as shown by the angle of the slope, as well as the attained EMG level shown by the mean.

A discriminant function analysis was carried out to establish the linear cordination of weighted scores that would best separate out the relaxation-behaviour groups.

The first of the 4 discriminant functions obtained was significant (p = 0.04). However, the variables that were included in the function, Trait, IBQ, Firsurg, PainLS and Lie did not contribute significantly ($p < 0.01$) to the differences between the relaxation behaviour groups.

Therefore, the groups were collapsed to give 2 new groups:

Group 1: Relaxing, included relaxed, decreasing EMG, resting.

Group 2: Tensing, included increasing EMG, tense.

One significant discriminant function was obtained ($p = 0.01$) and the variables which contributed significantly to it were State ($p = 0.03$), Trait, Feedback and Lie ($p = 0.01$).

The standardized canonical discriminant function was as follows:-

Function = .58 S + .56 T - .56 F + .49 L

TABLE 13

GROUP MEANS OF SIGNIFICANT VARIABLES/RELAXATION.

	Group	
	Relaxing	Tensing
State	36.0	41.9
Trait	38.2	43.1
Feedback	.61	.35
Lie	4.2	4.9

Inspection of the group means showed that subjects who relaxed during a session had lower scores on Trait and State anxiety, the Lie score, and were more likely to have been in the feedback situation. This function identified correctly 83.33% of the patients as belonging to either the relaxing or tensing groups.

IV. 4.3. <u>Discrimination on Rectus Abdominis Muscle Activity, Day 0.</u>

Although mean levels for the EMG of the rectus abdominis muscle were less than 1μv, 12 subjects showed higher activity, and an attempt was made to discriminate these two groups. The activity of the forehead muscles was included as a further independent variable.

Variables entering the equation, State, Trait and Forehead EMG, had significant levels greater than 0.05 but the discriminant function obtained was not statistically significant ($p = 0.11$).

IV. 4.4. Discrimination on Morphine

The set of variables included significantly in the previous discriminant functions were used to discriminate low (0 - 40 equivalent grams) and high (> 40 equivalent grams) morphine users.

The standardized canonical discriminant function obtained was significant ($p = 0.004$) and contained two variables, illness behaviour and PainLS. This function correctly classified 71.4% of subjects. However, the two variables were correlated ($r = 0.3$, $p = 0.03$) and so PainLS was discarded and a further discrimant function calculated, using the scales of the IBQ.

The scales of the IBQ, with abbreviations are general hypochondriasis (H), disease conviction (DC), psychological vs somatic functioning (PS), affective inhibition (AI), affective disturbance (AD), denial (D), and irritability (I).

The four scales which predicted morphine use were irritability, somatic functioning, affective disturbance and denial. Again, 71.4% of subjects were correctly classified as low or high morphine users.

Function = .9I - .57PS -.38AD + .37D

DIAGRAM 1

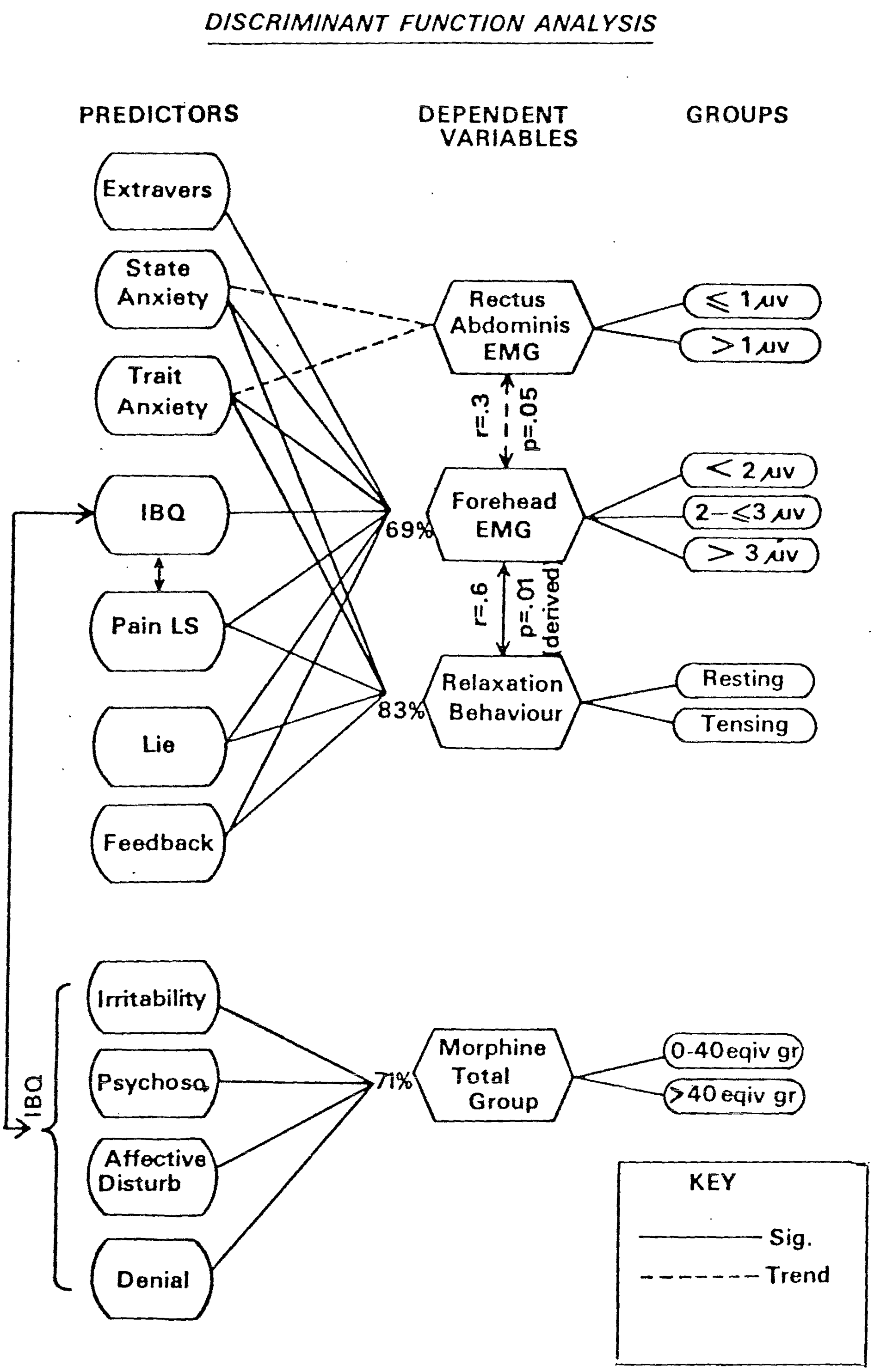

DISCRIMINANT FUNCTION ANALYSIS
PREDICTORS
DEPENDENT VARIABLES
GROUPS
Extravers
State Anxiety
Trait Anxiety
IBQ
Pain LS
Lie
Feedback
Rectus Abdominis EMG
Forehead EMG
Relaxation Behaviour
69%
83%
r=.3
p=.05
r=.6
p=.01 (derived)
≤ 1 μv
> 1 μv
< 2 μv
2–≤3 μv
> 3 μv
Resting
Tensing
IBQ
Irritability
Psychoso
Affective Disturb
Denial
71%
Morphine Total Group
0-40 eqiv gr
>40 eqiv gr
KEY
Sig.
Trend

TABLE 14.

GROUP MEANS OF SIGNIFICANT VARIABLES/MORPHINE

	Groups	
	Low Morphine	High Morphine
Somatic functioning	3.828	2.912
Affective Disturbance	0.453	0.212
Denial	1.367	1.632
Irritability	0.56	1.305

Examination of weightings and group means showed the importance of irritability; the patients who were given more morphine were those who had more angry feelings (Pilowsky, 1981). They were more likely to deny problems in their lives.

IV. 4.5. Summary of Discriminant Function Analyses

1. Muscle tension in the forehead muscles was related to State and Trait anxiety.
2. Women who had difficulty relaxing during a session showed more State and Trait anxiety and were more likely to exaggerate (L score).
3. The abdominal muscle tension may also have reflected anxiety.
4. The patients who received more morphine were those who had more angry feelings.

IV. 5. FACTOR ANALYSIS OF SENSORY AND AFFECTIVE QUALITIES OF PAIN.

IV. 5.1. The McGill adjective questionnaire, as adapted by Leavitt (1978) was administered to all experimental and control subjects, plus an additional 30 patients..

Responses to the 86-item pain adjective questionnaire were tallied over the 103 subjects to determine the frequency of their use in describing pain after hysterectomy.

Table 15 shows the most frequently and least frequently given responses.

TABLE 15.

Most Common		Least Common	
Item	No. of Responses	Item	No. of Responses
Aching	64	Freezing	1
Sore	61	Lancinating	1
Annoying	55	Beating	3
Tender	55	Itchy	3
Tiring	54	Suffocating	3
Miserable	50	Crushing	4
Nagging	50	Scolding	4
Continuing	45	Blinding	5
Pulling	44	Cool	5
Continuous	42	Jumping	5
Steady	42		

The least common adjectives were dropped from further analysis and the remaining 76 words were inter-correlated. A principal component analysis with varimax rotation was applied to the correlation matrix. 22 factors with Eigen values greater than 1 were extracted which together accounted for 76% of the variance. It was decided that for a factor to be meaningful it should have at least 2 loadings greater than 0.45. Using this standard 14 factors were finally identified which together accounted for 60.2% of the variance. These are shown in Table 16.

TABLE 16.

VARIMAX ROTATED FACTORS AND FACTOR LOADINGS WITH % OF VARIANCE AFTER VARIMAX.

Factor 1.	20.3%	
Frightful	0.78	A
Cruel	0.75	A
Punishing	0.73	A
Agonising	0.71	A
Piercing	0.70	S
Torturing	0.68	A
Dreadful	0.67	A
Killing	0.64	A
Unbearable	0.54	E
Penetrating	0.54	S
Wrenching	0.49	S
Fearful	0.47	A
Wretched	0.46	A

Factor 2.	6.2%	
Constant	0.67	S
Continuous	0.63	S
Continuing	0.62	S
Steady	0.58	S
Tiring	0.52	A
Intense	0.51	E
Nagging	0.47	A

Factor 3	4.8%	
Radiating	0.69	S
Flickering	0.64	S
Searing	0.49	S
Drilling	0.46	S
Splitting	0.46	S

Factor 4	3.8%	
Brief	0.68	S
Momentary	0.67	S

Factor 5.	3.6%	
Stinging	0.73	S
Tingling	0.60	S

Factor 6.	3.4%	
Dull	0.63	S
Annoying	0.54	E
Periodic	0.49	S

Factor 7	3.1%	
Tender	0.59	S
Light	0.59	S

Factor 8.	3.0%	
Cutting	0.70	S
Tearing	0.70	S

Factor 10.	2.6%	
Flashing	0.77	S
Transient	0.54	S

Factor 11.	2.5%	
Gruelling	0.60	A
Rasping	0.47	S

Factor 12.	2.1%	
Pinching	0.64	S
Numb	0.50	S

Factor 18.	1.7%	
Tugging	0.60	S
Drilling	0.45	S

Factor 19.	1.6%	
Sickening	0.57	A
Nauseating	0.56	A

Factor 20.	1.5%	
Pulling	0.68	S
Spreading	0.47	S

KEY TO ADJECTIVE CATEGORY.

A = Affective
S = Sensory
E = Evaluative

TABLE 17.

COMPARISON OF COMPOSITION OF FACTORS 1.

BACK PAIN (LEAVITT)		HYSTERECTOMY			
		Factor 1		Factor 19	
Vicious	A				
Frightful	A	Frightful	A		
Cruel	A	Cruel	A		
Torturing	A	Torturing	A		
Wretched	A	Wretched	A		
Dreadful	A	Dreadful	A		
Sickening	A			Sickening	A
Killing	A	Killing	A		
Terrifying	A				
Punishing	A	Punishing	A		
Miserable	E				
Crushing	S				
Exhausting	A				
Fearful	A	Fearful	A		
Agonising	A	Agonising	A		
Intense	E				
Cutting	S				
Splitting	S				
Stabbing	S				
Unbearable	E	Unbearable	E		
Heavy	S				
Nauseating	A			Nauseating	A
		Piercing	S		
		Penetrating	S		
		Wrenching	S		

The prepondance of affective adjectives in Factor 1, which accounted for 20.3% of the total variance was compared with the composition of Factor 1 obtained by Leavitt in his study of chronic back pain. (Table 17) Factor 19, also, was composed only of affective adjectives. Factors 1 and 19 together explained 21.9% of the variance in adjectives used to describe the pain experienced in the first 3 days after a hysterectomy and this was attributed almost entirely to emotional discomfort. The sets of affective adjectives used by both back-pain patients and hysterectomy patients were similar whereas the sets of sensory adjectives were entirely different. Factors 2 and 11 which were mixed sensory and affective adjectives accounted for 8.7% of the total variance.

The remaining factors were entirely sensory (apart from one evaluative adjective) and accounted for 29.6% of the total variance of the adjectives describing the pain experience.

Thus, of the 60.2% of total variance explained by these factors, 30.6% entailed emotion and 29.6% was attributable to sensation alone.*

IV. 5.2. Factor 1 was a Dependent Variable

Factor 1 was named by Leavitt, "severe emotional discomfort", and the same label seemed appropriate for this study. Factor score coefficients were used to calculate a score for each subject. These scores, called pain-factor, were used as a further dependent variable, representing a dimension of the total pain experience. Pain-factor correlated with pain-analogue ($r = 0.3589$, $N = 45$, $p = 0.008$) which gave some validity to the use of pain-analogue as a variable in this study in spite of its unreliability due to missing data.

Postscript from an adjective questionnaire:-

"My pain has been with me all the time but was intense for a 4-hour period on Day 2.

It helps to be alert so control can be regained.

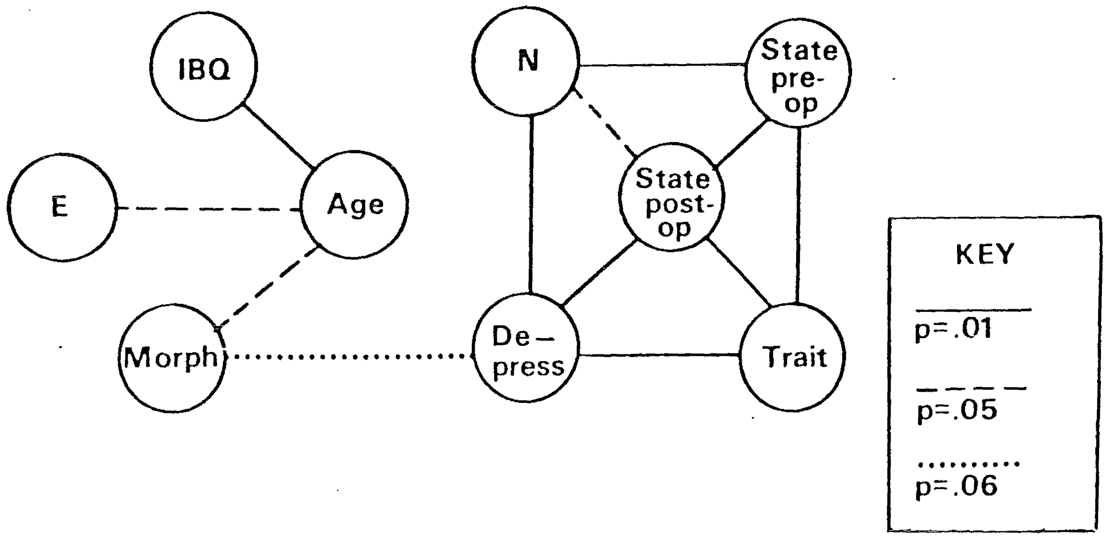
It helps not to be alone, as that is like death."

---

* It was possible that further manipulation of the axes would have further reduced the number of factors, and increased the meaning of the analysis, but such a procedure was beyond the scope of the present thesis.

DIAGRAM 2

CORRELATIONS ACROSS ALL SUBJECTS N=73



CORRELATIONS WITH AGE, Experimental Subjects

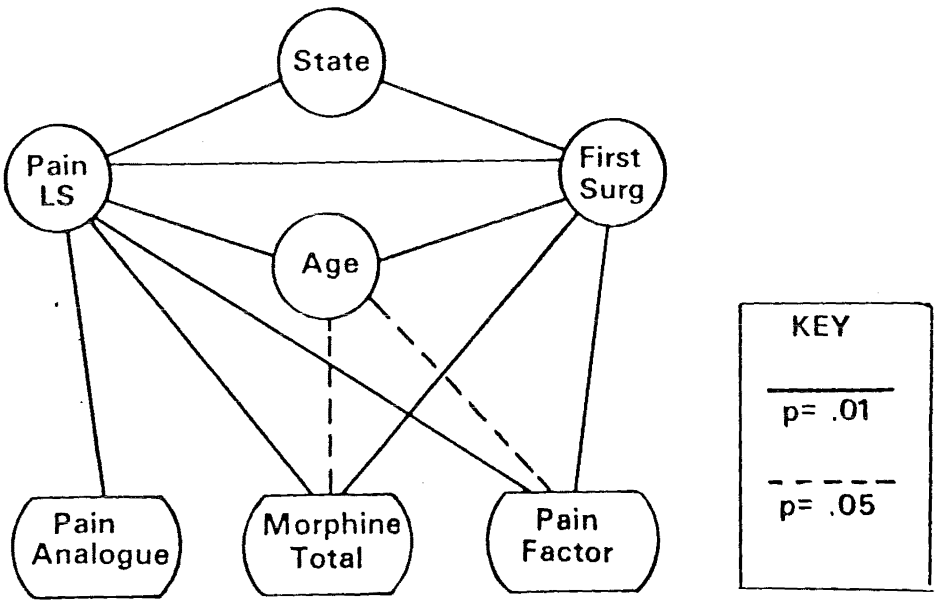


DIAGRAM 4

IV. 6. PEARSON'S CORRELATIONS

The descriptive analysis showed that subjects in the experimental groups for whom relaxation behaviour was reinforced either directly by auditory feedback, or by attention and encouragement, were given less morphine than the control subjects.

Discriminators of muscle activity, the ability to relax, and morphine use were identified, but no direct relationship between EMG and morphine use was found. A further variable pain-factor was calculated.

Bivariate correlation analysis was used to examine direct and indirect relationships between all those variables in order to explain how muscle relaxation behaviour could effect the outcome variable of total morphine use.

Correlations are discussed in the following order:-

1. Correlations across all subjects. (N = 73)
2. Correlations of EMG measures. (N = 49)
3. Correlations of all variables across experimental subjects. (N= 48)
4. Anxiety correlations; all subjects/experimental subjects.
5. Correlations between Illness Behaviour Questionnaire scales and other variables. (N = 48)

IV. 6.1. Correlations across all subjects are given in Table 18 and demonstrated in Diagram 2. The younger patients showed more illness behaviour, less extraversion and were given more morphine than the older patients.

State anxiety, measured post-operatively, related more strongly to depression, neuroticism and trait anxiety than did the pre-operative measure of the same test.

A negative correlation was revealed between depression and morphine/weight. On the third day post-operatively when the

Zung SDS questionnaire was administered, patients who had had high total doses of morphine may still have been euphoric from doses given that day, which would account for the result that high total-dosage morphine subjects were less depressed. Depression scores, therefore, were treated with reservation in further analysis.

TABLE 18.

CORRELATIONS ACROSS ALL SUBJECTS.

Variable 1	Variable 2	r	Significance
Age	IBQ	0.4110	>0.001
	Extraversion	-0.2647	0.024
	Morphine	-0.2615	0.025
	Morphine/ weight	-0.3.52	0.009
Depression	State, post-operative	0.4219	>0.001
	Trait	0.5448	>0.001
	Neuroticism	0.3867	>0.001
	Morphine/ weight	-0.2259	0.056
State, pre-op.	State, post-op. SD S	0.3373	0.004
	Trait	0.2976	0.011
	Neuroticism	0.2522	0.03
State, post-op.	Trait	0.6415	>0.001
	Neuroticism	0.4503	>0.001

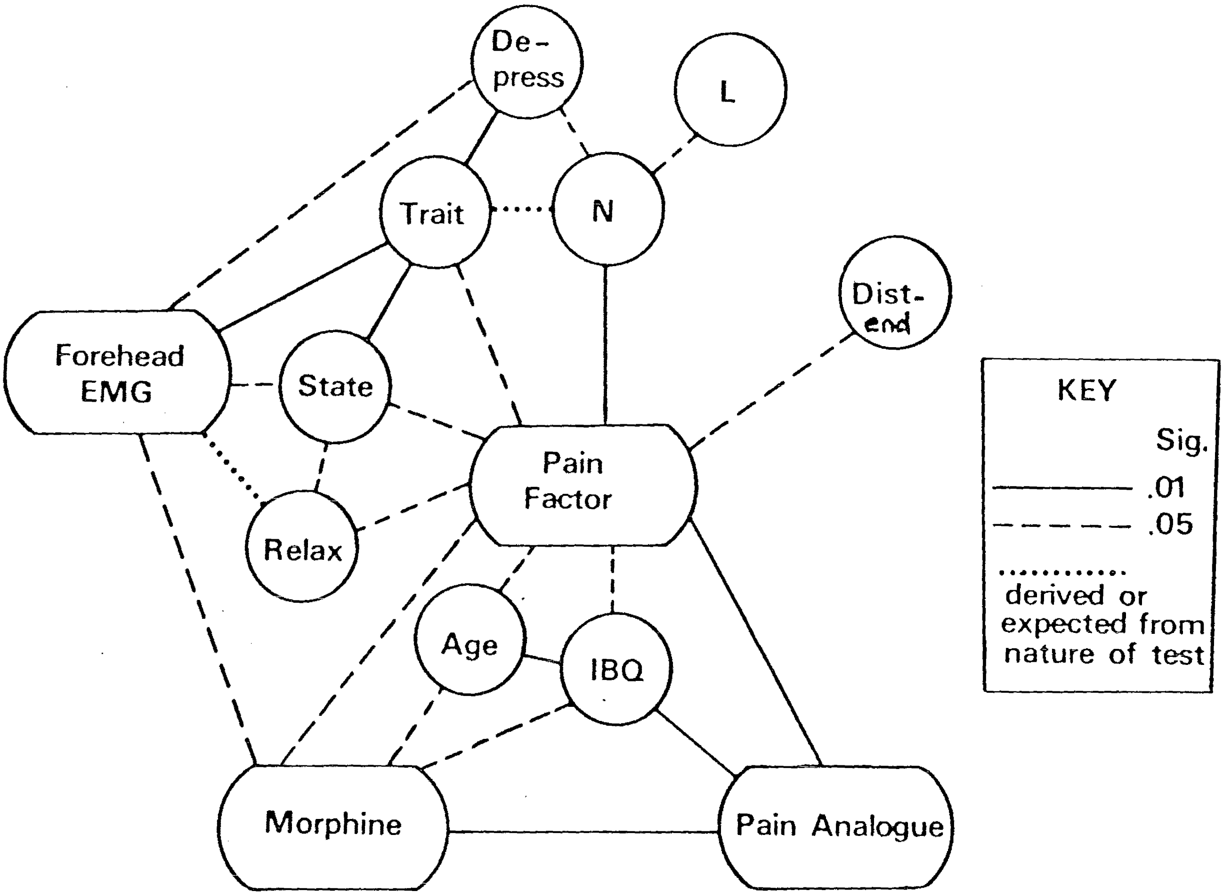
IV. 6.2. Forehead EMG measures for each of the four days and the total EMG summed across the four sessions all correlated with each other significantly (Table 19).

The forehead EMG measure in the pre-operative session was not confounded by morphine usage and correlated with each of the other days and with total forehead activity and so could be used reliably to predict activity. This measure was the main EMG measure used in further analysis.

Rectus abdominis muscle activity correlated with forehead

DIAGRAM 3

CORRELATION RELATIONSHIPS, Experimental Subjects



activity on Day 0, ($r = 0.2929$, $p = 0.05$). Forehead EMG activity on Day 0 correlated with trait anxiety ($r = 0.42$, $p = 0.004$).

TABLE 19.

FOREHEAD EMG CORRELATIONS

Variable 1	Variable 2	r	Significance
Day 0	Day 1	0.4240	0.002
	Day 2	0.4297	0.002
	Day 3	0.5524	0.001
	Total	0.7678	0.001
Day 1	Day 2	0.5526	0.001
	Day 3	0.3823	0.007
	Total	0.7767	0.001
Day 2	Day 3	0.4774	0.001
	Total	0.8111	0.001
Day 3	Total	0.7421	0.001

IV. 6.3. Correlations across all the experimental subjects of dependent and independent variables are given in Table 20 and demonstrated in diagrams 3 and 4.

Correlations with a significance greater than or equal to $p = 0.05$ were examined. The dependent variables of morphine, pain-factor and pain-analogue significantly correlated with each other. Forehead EMG and depression were correlated but the depression score was possibly confounded by morphine use (IV. 6.1.) Forehead EMG (Day 0) correlated negatively with morphine use ($p = 0.056$), so that higher muscle tension prior to surgery was not a prediction of higher morphine use.

Illness behaviour correlated with each of the dependent variables and with age. Age, shown separately (diagram 4) because of its multiple connections correlated with morphine and pain-factor, had an indirect relationship with state anxiety as both correlated with "first surgery" and "pain lead to design for surgery."

State and trait anxiety correlated with both pain-factor and forehead EMG.

"Distend", the only variable that attempted to measure an aspect of pain as a sensation, had a negative correlation with pain-factor which was a measure of the affective nature of pain.

Thus, it appeared that the variables likely to be important in connecting relaxation behaviour and muscle tension with the outcome variables were age, state and trait anxiety and illness behaviour.

IV. 6.4. The correlations between the anxiety measures were re-examined and are shown in Table 21.

In the results for both experimental population and the total population there was a strong correlation between trait anxiety and the post-operative measure of state anxiety.

The pre- and post-operative measures of state anxiety correlated with each other in both populations. However, the pre-operative measure of state anxiety did not correlate with trait anxiety in the experimental population, whereas it did in the total population. No difference between the mean of experimental and control subjects were observed (IV. 2.4.) It appeared, therefore, that the nature of state anxiety pre-operatively and post-operatively varied more in the experimental population than in the total population. The pre-operative measure of state anxiety was used in further multivariate analyses.

(See Appendix 6, Scattergrams)

TABLE 20.

CORRELATIONS ACROSS EXPERIMENTAL SUBJECTS.

VARIABLE 1	VARIABLE 2	r	SIGNIFICANCE
Age	First Surgery	-0.3511	0.007
	Pain Leading to Surgery	-0.3646	0.005
	Pain-Analogue	-0.2636	0.04
	Morphine	-0.2823	0.026
	Morphine/Weight	-0.332	0.011
	Illness Behaviour*	0.4552	0.001
	Pain-factor	-0.2862	0.024
State Anxiety (pre-op)	First surgery	0.4043	0.002
	Pain leading to Surgery	0.3717	0.005
	Pain-factor	0.3359	0.01
Trait Anxiety	Depression	0.5125	0.001
	Pain-factor	0.3333	0.01
First Surgery	Pain leading to Surgery	0.9498	0.001
	Morphine	0.3609	0.006
	Morphine/weight	0.2703	0.033
	Illness behaviour	-0.3455	0.008
	Pain-factor	0.3498	0.007
Pain leading to Surgery	Morphine	0.3460	0.008
	Morphine/weight	0.2559	0.041
	Illness behaviour	-0.3070	0.017
	Pain-factor	0.3391	0.009
Pain-Analogue	Morphine	0.3959	0.004
	Morphine/weight	0.4765	0.001
	Illness Behaviour	-0.4051	0.003
	Pain-factor	0.3589	0.008
Morphine	Illness Behaviour	-0.3280	0.011
	Pain-Factor	0.2461	0.046
Morphine/weight	Illness Behaviour	-0.3891	0.003
	Pain-Factor	0.2262	0.063
Illness Behaviour	Pain-Factor	-0.2777	0.028
Forehead EMG, Day 0	Trait Anxiety	0.4021	0.002
	Depression	0.2594	0.038
	Morphine	-0.2369	0.053
	Morphine/weight	-0.2696	0.036
Relax	State Anxiety	0.2934	0.023
	Trait Anxiety	0.2346	0.054
	Pain Leading to Surgery	0.2471	0.045

TABLE 20 (cont)

VARIABLE 1	VARIABLE 2	r	SIGNIFICANCE
Extroversion	Age	-0.3240	0.012
	Pain leading to Surgery	0.2655	0.034
	Morphine	0.2460	0.046
Distression	Pain-Factor	-0.2514	0.042

* Illness behaviour scores: lower scores indicate more illness behaviour.

TABLE 21.

CORRELATIONS OF ANXIETY

	State Anxiety Pre-op.	State Anxiety Post-op.	Trait Anxiety	
State Anxiety Pre-op		r = 0.3373 n = 73 p = 0.004	r = 0.2976 n = 72 p = 0.011	TOTAL
State Anxiety Post-op	r = 0.2853 n = 48 p = 0.05		r = 0.6418 n = 73 p = 0.001	POPULAT-ION
Trait Anxiety	r = 0.1908 n = 47 p = 0.099	r = 0.3797 n = 48 p = 0.01		

EXPERIMENTAL POPULATION

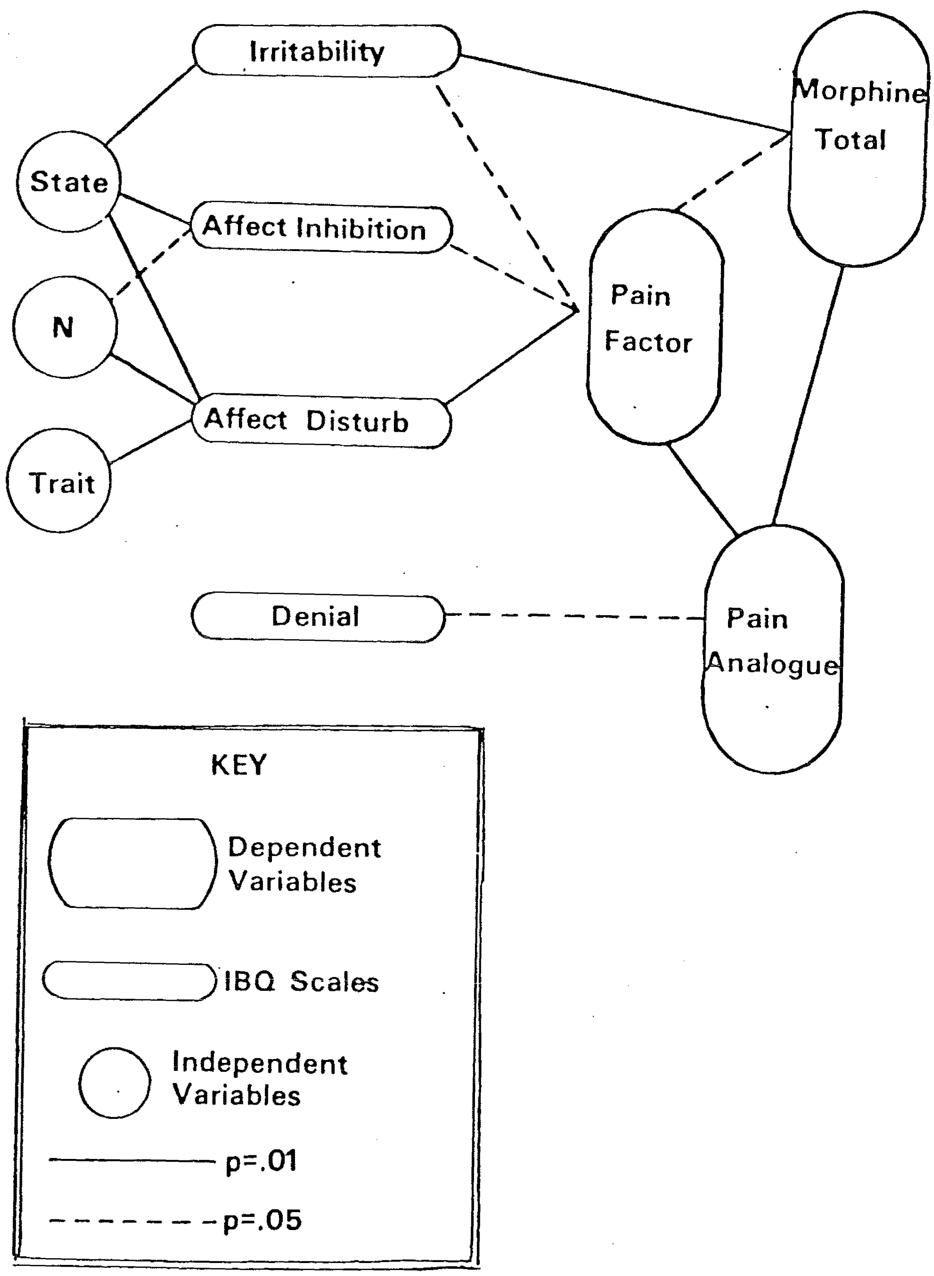
IV. 6.5. Correlations between the scales of the Illness Behaviour questionnaire and other psychological and outcome variables were examined. (Table 22 shows significant correlations)

Irritability related to morphine useage, denial related to pain-analogue, and irritability, affective inhibition and affective disturbance correlated significantly with pain-factor. These relationships are demonstrated in diagram 5.

As irritability was the only scale to correlate with

DIAGRAM 5

ILLNESS BEHAVIOUR SCALES AND CORRELATIONS



morphine useage, its correlations with all other variables in the study were examined and are demonstrated in diagram 6. (Table 23)

TABLE 22.

CORRELATIONS WITH IBQ SCORES - EXPERIMENTAL SUBJECTS.

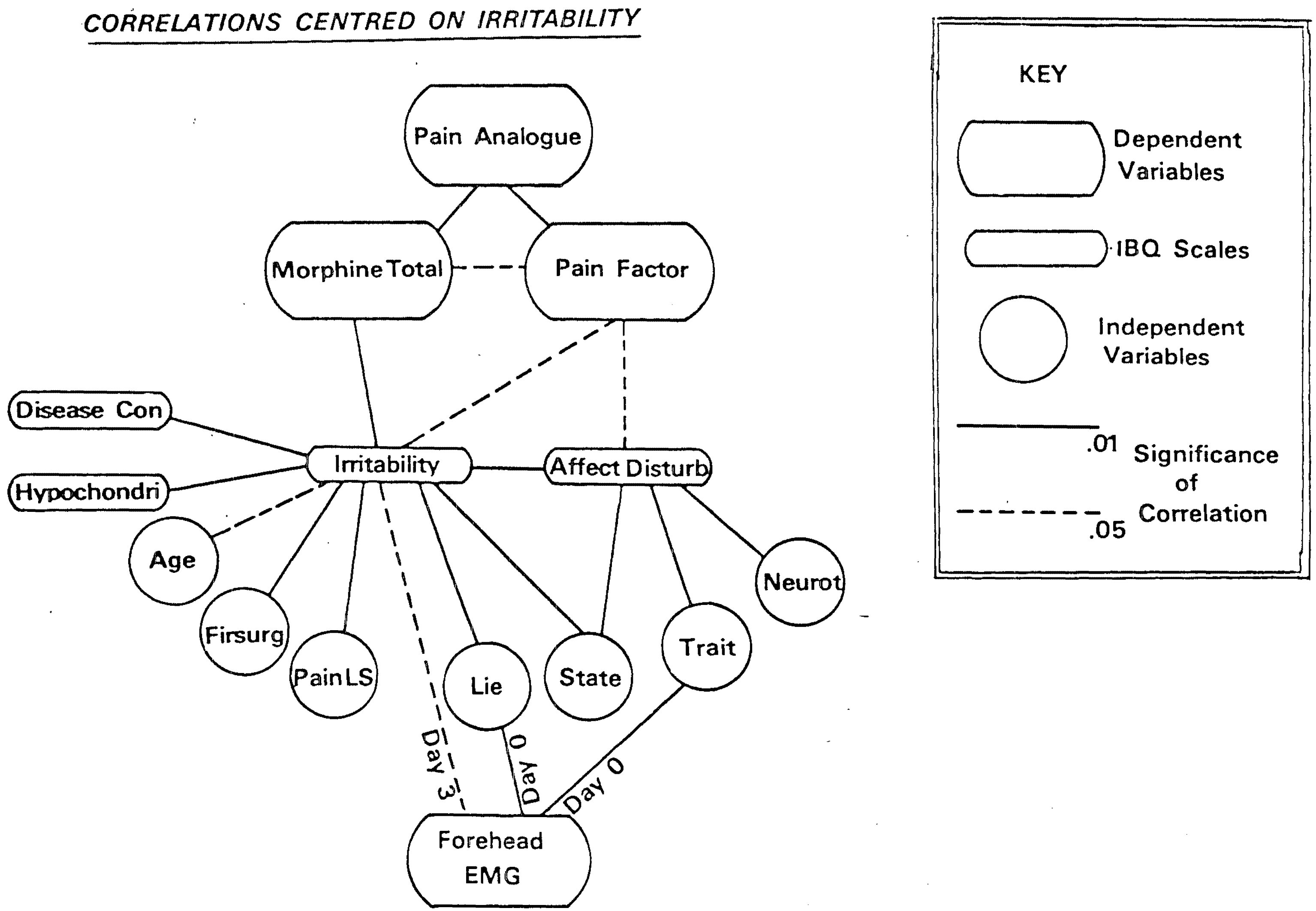
Variable 1	Variable 2	r	Significance
Irritability	Age	-0.2399	0.05
	State Anxiety	0.3449	0.008
	Pain-Factor	0.2635	0.035
	Morphine	0.3481	0.008
Affective Disturbance	State Anxiety	0.4723	0.001
	Trait Anxiety	0.4067	0.002
	Neuroticism	0.5730	0.001
	Pain-Factor	0.3454	0.008
Affective Inhibition	State Anxiety	0.3091	0.016
	Neuroticism	0.2538	0.039
	Pain-Factor	0.2522	0.042
Denial	Pain-Analogue	0.3501	0.021
Hypochondriasis	State Anxiety	0.2438	0.047
	Trait Anxiety	0.3777	0.004
	Extraversion	0.3919	0.003
	Neuroticism	0.3919	0.003
	Lie	-0.2744	0.028
Disease Conviction	Age	-0.4107	0.002
	State Anxiety	0.3605	0.006
Psychosomatic	-	-	-

IV. 6.6. Summary of Correlation Results

Examination of Diagrams 2-6 show the importance of age, state and trait anxiety, the lie score and neuroticism, and of the illness behaviour scales, irritability and affective disturbance.

The correlation between forehead muscle activity on the third day after surgery and irritability was negative. Correlations on other days were not significant. There was, therefore, no consistent pattern that suggested that changes in forehead EMG

DIAGRAM 6



CORRELATIONS CENTRED ON IRRITABILITY
Pain Analogue
Morphine Total
Pain Factor
Disease Con
Hypochondri
Irritability
Affect Disturb
Age
Firsurg
Pain LS
Lie
State
Trait
Neurot
Day 3
Day 0
Day 0
Forehead EMG
KEY
Dependent Variables
IBQ Scales
Independent Variables
.01
.05
Significance of Correlation

were indicative of changes in irritability.

TABLE 23.

CORRELATION WITH IRRITABILITY.

VARIABLE 1	VARIABLE 2	r	SIGNIFICANCE
Irritability	Age	-0.2399	0.05
	State Anxiety	0.3449	0.008
	Lie	-0.2329	0.056
	First Surgery	0.3303	0.011
	Pain led to surgery	0.3227	0.013
	Hypochondriasis	0.3844	0.003
	Disease Conviction	0.4509	0.001
	Affective Disturbance	0.4427	0.001
	Forehead EMG, Day 3	-0.2526	0.042
	Pain-Factor	0.2635	0.035
	Morphine	0.3481	0.008
	Morphine/weight	0.3421	0.009

IV. 7. MULTIPLE REGRESSION ANALYSES

In multiple regression analysis, multiple R^2 is the variation in Y explained by the combined linear influence of the independent variables relative to the total variation in Y, so that an equation can be given of the form:

$$Y = a + b_1x_1 + b_2x_2 \ldots \quad b_jx_j \quad \ldots b_nx_n \quad + e$$

Y is the predicted value of the criterion variable

a is the constant or Y-intercept of the regression

b is the slope

x is the value of the score obtained

e is error.

This regression equation provides a prediction of the Y value given the values of x.

Multiple R^2 is the variation in Y explained by the combined linear influence of the independent variables relative to the total variation in Y. The relationship between R^2 and F is given as:-

$$F\ (K,\ N\text{-}K\text{-}1) = \frac{\frac{R^2}{K}}{\frac{1 - R^2}{N\text{-}K\text{-}1}}$$

(where N = number of subjects,
(and K = number of variables
(entered into equation.

This test of significance for multiple R^2 gives the overall goodness of fit of the regression equation. The Beta values are the standardised regression coefficients,and F-ratios were used in tests of significance of the individual betas with 1, and N-K-1 degrees of freedom. (Refer Table 24). The stepwise forward inclusion procedure identifies that variable for the equation which has the highest partial correlation, and, therefore, is the best predictor of Y, and then calculates a partial - F to see if the increase in the predicted variance is significant. If not significant the procedure stops. If it is significant, a regression equation is printed out including this variable, and the procedure

TABLE 24: MULTIPLE REGRESSION

Criterion Variable	Step	Predictor Variable	R^2	Change R^2	Test for R^2: K,N-K-1 df	Test for R^2: F	Test for R^2: Sig.	Beta	Test for Beta: 1,N-K-1 df	Test for Beta: F	Test for Beta: Sig.
UT	1	Pain Analogue	.132	.132	1.42	6.401	.015	.315	1.42	5.234	.027
	2	Irritab	.24	.107	2.41	6.465	.004	.313	1.41	5.271	.027
or	3	Fronto	.267	.027	3.40	4.859	.013	-.169	1.40	1.491	NS
		Constant	33.7								
UTW	1	Pain Analogue	.227	.2271	1.42	12.337	.001	.43	1.42	11.16	.002
	2	Irritab	.337	.0696	2.41	8.645	.001	.318	1.41	6.24	.017
	3	Fronto	.361	.0293	3.40	6.446	.001	-.158	1.40	1.5	NS
		Constant	32.1								
PAIN-FACTOR	1	Neurotic	.23	.23	1.40	11.94	.001	.396	1.40	9.63	.003
	2	Age	.327	.097	2.39	9.46	.001	-.297	1.39	5.84	.02
	3	State	.386	.059	3.38	7.96	.001	.318	1.38	5.86	.02
	4	Denial	.442	.056	4.37	7.34	.001	.246	1.37	3.73	NS
		Constant	-.328								
FRONTO	1	Trait	.177	.177	1.40	8.572	.006	.494	1.40	14.39	.001
	2	Lie	.287	.111	2.39	7.849	.001	.288	1.39	5.82	.021
	3	Feedback	.381	.094	3.38	7.789	.001	-.299	1.38	7.21	.011
	4	Denial	.42	.039	4.37	6.635	.001	-.107	1.37	2.34	NS
		Constant	-82.17								
PAIN-ANALOGUE	1	AIBQ	.159	.159	1.42	7.94	.007	-.329	1.42	5.32	.026
	2	Factor 1	.223	.064	2.41	5.87	.006	.262	1.41	3.36	NS
		Constant	33.7								
or											
PAIN-ANALOGUE	1	Factor 1	.122	.133	1.42	5.83	.02	.318	1.42	5.071	.03
	2	Denial	.195	.073	2.41	4.96	.002	.272	1.41	3.717	.06
		Constant	111.2								
AIBQ	1	Psychosom	.557	.557	1.42	52.68	.001	.566	1.42	2283.	.001
	2	Irritab	.738	.182	2.41	57.7	.001	-.289	1.41	525.	.001
	3	Denial	.849	.112	3.40	75.2	.001	-.485	1.40	1421.	.001
	4	Disease Conv.	.991	.142	4.39	1107.2	.001	-.418	1.39	776.	.001
	5	Age	.995	.004	5.38	1565.2	.001	.072	1.38	31.	.001
		Constant	51.4								

repeats itself with the solution of the best of the remaining independent variables.

The stepwise multiple regression analyses are summarised in Table 24. Tests of significance for multiple R^2 are all shown to be significant. Tests for significance of Beta are shown; and constants are given.

IV. 7.1. AIBQ Score

This score was calculated from 4 scales of the IBQ (Pilowsky 1979, p204) and the relative contribution to this score by each scale was required. Psychosomatic predicted 56% of the variance, Irritability 18%, Disease Conviction 14%, Denial 11% and Age less than 1%. (Note: Affective disturbance is a scale of the IBQ but is not a part of the AIBQ score, by definition).

IV. 7.2. EMG, Forehead, Day 0.

38% of the variance was explained by Trait (18%), Lie (11%) and Feedback (9%).

IV. 7.3. Total Morphine

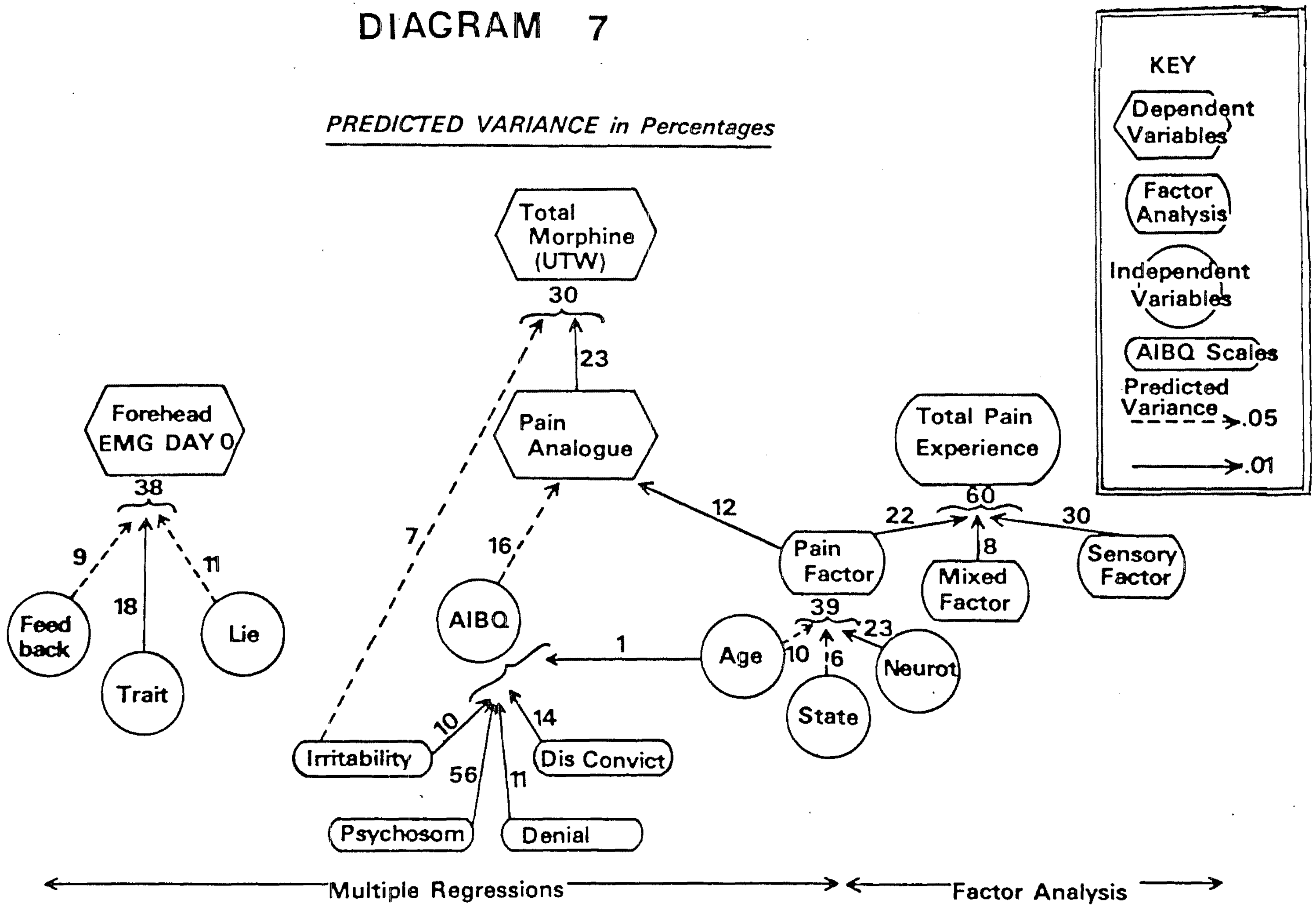
The results of regressions on both total morphine and total morphine adjusted for body weight are shown and between 24%-30% of variance was predicted. The pain that people say they felt (pain-analogue) accounted for 13%-23% of the variance of morphine usage.

However, pain-analogue was an unreliable measure and also, no note was made of either the time of pain-scoring or analgesic administration.

It was noted that morphine was administered in a varied fashion (appendix 5) and the question could arise as to whether analgesic administration was a function of the patient's needs, the doctor's preference or the ward's nursing routine. Further

DIAGRAM 7

PREDICTED VARIANCE in Percentages



investigation of this dimension was outside the scope of this study.

IV. 7.4. Pain-Analogue

A multiple regression equation could not be obtained because the only 2 variables that entered the equation, AIBQ and pain-factor, were correlated. ($r = -0.278$, $N = 48$, $p = 0.028$) Each, separately, in a bivariate correlation, predicted 16% and 12% of the variance of pain-analogue respectively.

IV. 7.5. Pain-Factor

Age, state anxiety and neuroticism together accounted for 39% of the variance.

IV. 7.6. The results of these multiple regressions are demonstrated in diagram 7. The variables that were relevant in this search for an explanation of why subjects who were given relaxation training required less morphine, were age, state and trait anxiety, the lie score, neuroticism and irritability.

V. DISCUSSION

V.1. SUMMARY

No differences were apparent between experimental and control subjects on the psychological variables or on age, although within the experimental and control groups those subjects having the abdominal surgical procedure were younger than those having the vaginal procedure. Abnormal illness behaviour was evident in 36% of the population and 37% of the patients were depressed three days after the operation. This depression estimate was probably conservative as a negative correlation between depression and morphine usage suggested that those subjects who had had more morphine could still have been experiencing its euphoric effects at the time of filling in the questionnaire.

More morphine was given to the control subjects than to the experimental subjects in both surgical conditions and the abdominal hysterectomy patients were given more morphine than the vaginal hysterectomy group.

The pain-analogue measure of reported pain was unreliable because of missing data. Within the vaginal hysterectomy group control subjects reported more pain than experimental subjects but no differences showed in the abdominal hysterectomy group.

Factor analysis of the McGill list of adjectives that patients used to describe their pain experienced after their operation allowed the calculation of another dependent variable that reported the subjective pain experience. This variable was labelled pain-factor and was described as "severe emotional discomfort".

The question to be answered was that of what was happening to patients in the experimental groups from whom relaxation behaviour was expected.

The action of the two muscle groups, monitored electromyographically, differed. During the relaxation practice sessions the rectus abdominis muscle showed normal resting behaviour after both surgical procedures. The forehead muscle area showed activity that decreased during the 20 minute session. Auditory feedback during that period was an effective method of training a person to reduce the forehead muscle activity except on the first post-operative day when most patients had had their largest doses of morphine and many did not appear to attend to stimuli. However, the auditory feedback was not the necessary component; reinforcement of relaxation behaviour probably occurred in an unstructured way by attention, presentation of performance graphs and the nurses' interest. Although the EMG of the forehead muscles decreased over time more in the feedback than the no-feedback subjects, there was no difference between those groups in morphine use. Therefore, there was no direct explanation in terms of muscle tension of the differences in outcome measured by morphine use.

The predictor variables that discriminated muscle activity and the ability to relax were trait anxiety, illness behaviour and the lie score and the effect of feedback was also apparent. The only one of those variables that also discriminated high and low morphine users was illness behaviour. The irritability scale was important, such that patients who had more angry feelings were given more morphine. Correlations between predictor and outcome variables confirmed the importance of studying illness behaviour.

The distinction between state and trait anxiety was not clear-cut. State anxiety measured post-operatively correlated with trait anxiety.

Age was important. Younger patients, who were more likely to be having their first operation and for whom pre-operative pain lead to the decision to have surgery, were more likely to show illness behaviour. Their scores on the scales of "irritability" and "disease conviction" suggested that they were women who experienced angry feelings frequently, and that they were pre-occupied with symptoms with the possible rejection of a doctor's opinion (Pilowsky 1981). These younger patients received more morphine and appeared to be a more vulnerable group of subjects.

Multiple regression analyses confirmed the relevance to this study of the variables of age, state and trait anxiety, the lie score, neuroticism and irritability.

This study showed, therefore, that an emotional aspect of the subjective pain experience to which irritability contributed could be reduced with relaxation practice.

V. 2. COMPARISONS WITH LITERATURE

Other authors had looked at the applicability of relaxation training and practice as a means of ameliorating post-operative pain. This study did not support the suggestion by Madden (1979) that EMG-feedback from the abdominal muscles would be beneficial, as the abdominal muscles were already relaxed. It is supported comments by Lichter (1978) that staff observations confirmed the usefulness of pre-operative relaxation training, although that author was unable to support his claim with statistical significance. Perri (1979) did not show any reduction of pain after vaginal hysterectomy for subjects who had had 2 x 90 minute pre-operative sessions of progressive muscle relaxation training. Possibly the procedure used in the current study provided more reinforcement of relaxation behaviour; the EMG equipment aroused interest in most subjects and graphs of performance and staff attention were probably reinforcers. Alder (1978) commented that biofeedback techniques, while not necessary, may increase efficiency.

EMG activity in the forehead muscles appeared to be a physiological correlate of anxiety. This has often been assumed (Malno, 1951; Townsend, 1975) and has been demonstrated by Smith (1973). Qualls (1981) observed that the efficiency of biofeedback and progressive relaxation may vary as a function of trait anxiety. Anxiety has been posited by many as a factor that altered the threshold of pain (Egbert, 1964; Beecher, 1966; Haslem, 1966; Bowers, 1968; Spielburger, 1973; Gracely, 1978). Muscle relaxation was described by Wolpe (1958) as antagonistic to anxiety. Coldwell (1977) showed that fear arousal and anger both lowered the threshold of pain. In 1973, Wickramaskera questioned whether EMG decrease tied in with the subjective feeling of "letting go".

Feedback over time was a means of maximising the decrease in forehead EMG but was not an essential feature, as change in EMG was not the only manifestation of relaxation. Turk (1979) showed that biofeedback techniques were not necessarily any more effective than any other relaxation or cognitive control technique and the efficiency of biofeedback per se in reducing pain was marginal at least. EMG activity did not show any direct correlations with the dependent variables relating to pain in this study. However, the biofeedback approach was not dismissed as being of no consequence as the procedure appeared to be reinforcing of the desired relaxation behaviour. Qualls (1981) challenged the recent trend of concluding in favour of alternative relaxation procedures in terms of a cost-benefit analysis of their utility, saying that there was a danger that EMG biofeedback procedures could be disregarded before they had had a chance to mature.

The adjectival pain descriptors allowed calculation of a factor of "severe emotional discomfort" which paralleled Leavitt's (1978) results and supported the Melzack-Torgeson (1971) general taxonomy of pain. Those authors divided pain experience, broadly, into sensory sensations and affective reactions. Part of a patient's experience of pain was assumed to depend on sensation arising from tissue damage and part depended on the effect of the disturbance of the patient's mood.

This pain-factor correlated with morphine usage in such a way that patients with more severe emotional discomfort were given more morphine. Other authors have shown that morphine dose was associated with affect. Hill (1952) showed that morphine reduced pain only when anxiety was present, and Egbert (1967) showed that patients who were more confident in the outcome of their surgery, who by deduction would be less anxious, required less morphine. Chapman (1973) showed that Diazepam effected the motivational-emotional aspect of pain and that its administration resulted in a decrease in that state anxiety that was associated with the pain experience.

The younger patients were more vulnerable in this study and often gave pre-operative pain as the major reason leading to their decision to have surgery. Costulnuova-Toledo (1970) noted that emotional disturbance was almost a rule in patients with pelvic pain. Mills (1973) said that women under stress may present with pelvic symptons and that symptomatic relief by hysterectomy would not necessarily be successful. Ellis (1978) stressed the importance of a person's past experience of pain, as they could become conditioned to expect pain.

Depression was indicated but scores seemed to be confounded by the effects of morphine. The data tentatively support these authors who posited a high rather than a low incidence of depression after hysterectomy.

The lie score and its relevance to pain was not understood but its survival in this analysis confirmed Dalrymple's (1973) claim that more work was required in the study of "lie" and post-operative pain. To Dalrymple, people who scored high on lie were more prone to exaggerate or choose extremes. Osborne (1978), in reference to the lie score of the MMPI, described the relationship between scale L and muscle activity as suggesting that persons with greater objective tension were more rigid and naive than persons with lower levels of muscle activity. He described such people as being more likely to use denial as a defense mechanism. In the current study, denial (Pilowsky, 1978) was a predictor of morphine use and also correlated with pain-analogue.

Neuroticism predicted the pain-factor of emotional discomfort, and was shown by Dalrymple (1973) to be important in post-operative pain appreciation. Bond (1971) showed that the presence of a raised neuroticism score was a pre-requisite for the development of a 'social desirability set' indicated by a raised lie score, and that the presence of pain was related to neuroticism. Dalrymple (1976) concluded that the patient's neuroticism score had value in indicating susceptibility to pain, which appeared to be substantiated in this study.

VI. CONCLUSIONS

VI. 1. SUMMARY

1.1. The electromyographic biofeedback technique was a method of training a person to decrease muscle activity.

1.2. Auditory feedback of the analogue of muscle activity was not a necessary component of this study of the amelioration of post-operative pain after hysterectomy.

1.3 The rectus abdominis muscle relaxed in a normal manner. Therefore, localized muscle spasm was not contributing to pain during rest. However, pain due to muscle spasm during movement was not examined.

1.4 Forehead muscle activity reflected levels of trait anxiety. The lie score had a significance that was not explained.

1.5 Younger patients were more at risk. They described pain more emotionally, showed more illness behaviour and were given more morphine. Their decision to have surgery was influenced by the presence of pre-operative pain.

1.6 Irritability, one of the scales of the Abnormal Illness Behaviour Questionnaire, was a key variable. It is probable that relaxation behaviour is antagonistic to irritability.

VI. 2. RECOMMENDATIONS

2.1. Relaxation training prior to surgery and reinforcement of relaxation behaviour after surgery would be beneficial to patients who are to have hysterectomies.

2.2 Psychological screening of patients using the Illness Behaviour Questionnaire, or the specific questions that comprise the scale of "irritability" would predict those patients who would be more likely to require larger doses of morphine.

2.3 Psychological assessment of younger patients for whom a hysterectomy was recommended would yield information relevant to a final decision of whether a hysterectomy was the most appropriate form of treatment.

2.4 Emotional support in the pre-operative, immediate post-operative and long term post-operative periods could be implemented for those subjects most at risk.

VI. 3. FURTHER RESEARCH

3.1. Further analysis of this data could look at patterns of co-variance between state and trait anxiety and between neuroticism and the lie score in relation to the dependent variables.

3.2. Patients could be re-tested with the psychological test battery a year post-operatively to assess the value of these tests as predictors of outcome.

3.3 The different schedules of medication could be examined in relation to the dependent variables to see if any could be identified as being more effective with different types of patients.

3.4 Depression questionnaires should be administered on occasions when a patient has not had morphine. In this study it would have been more satisfactory to have tested depression pre-operatively, and retested a week after the surgery.

3.5 More precise reinforcement for the collection of pain-analogue data by the nursing staff was required. The involvement of many people in data collection posed a problem.

3.6 A more precise identification of the diagnosis leading to surgery and a summary of the pathology report after surgery would yield dimensions related to supposed and actual pathology. Examination of those in relation to anxiety, illness behaviour and morphine useage could have been useful.

3.7. A factor analysis of the scores of the Illness Behaviour Questionnaire on a larger sample of subjects (about 150) is recommended in order to study any fundamental discrepancy between the objective pathology present and the patient's response to the pain of the hysterectomy.

3.8 Noise external to the hospital and from within the ward was troublesome and appeared to interfere with the relaxation, particularly when the auditory feedback was used (appendix 9, Noise in Decibels). Earphones should be used in further studies.

3.9 The procedure could be replicated on groups of patients having other forms of abdominal surgery for comparisons.

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APPENDIX 1: QUESTIONNAIRES USED IN STUDY.

POST-OPERATIVE PAIN

There is great variation in the degree of discomfort people experience after operation - surprisingly, perhaps, some have no real pain at all. We are trying to understand these differences and to do this need to know quite a lot about you. In this way we will be better able to help you and other patients.

We will be asking you to complete a number of questions about how you feel, how your operation is affecting you, what sort of pain you experience. This will involve several interviews both before and for three days after your operation.

The study will not interfere in any way with the treatment by your surgeon. We think it may make your stay in hospital more pleasant.

Relaxation can play a part in easing pain and so we would like to remind you of the need to allow yourself to relax both before and after surgery and during your convalescence at home. We will measure muscle tension in your stomach and forehead muscles which may well give much useful information. The measurements take about 30 minutes and cause no discomfort at all.

Our only requirement is that you can rest quietly during this period. If you have visitors we will ask that they sit quietly or go for a walk for the few minutes involved in the measurement.

All information gathered will be strictly confidential. No individual personal details will be retained or entered in your hospital file.

The study is being conducted by staff from the Department of Anaesthesia, Christchurch Clinical School of Medicine.

We would like to thank you for your co-operation.

J M Gibbs
Margaret Moon
Sharon Fountain

PRE-OPERATIVE DATA

Item	Columns
	1 (entered: 1)
Subject Code	2 3
Hospital Number	4 5 6 7 8 9
Surgical Group FA, FV, FC, HA, HV, HC, ZA, ZV, ZC, GA, GV, GC	10 11
SURGEON	12 – 22
G.P.	23 – 33
Age, years	34 35
Marital Status	36
Children group: (Ages) ______	37
Therapist's tolerance prediction	38
Is this your first experience of surgery? Yes 1, No 0.	39
Was pain an important factor leading to your decision to have this operation? Yes 1, No 0 (If zero, cc 61-80 blank)	40

STA1-X1 Questionnaire (next sheet) cc 41-60

History (third sheet if cc 40 ≠ 0) 61-80

1	Card (do not punch)
	Subject code (do not punch)

STAI-X1 Questionnaire - Pre-Operative

A number of statements which people have used to describe themselves are given below. Read each statement and indicate how you feel right now, that is, at this moment. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings best.

Use scale as follows:-

(1) Not at all
(2) Somewhat
(3) Moderately so
(4) Very much so

e.g. I feel happy [3]

* * * * *

Statement	Answer	
I feel calm		41
I feel secure		
I am tense		
I am regretful		
I feel at ease		45
I feel upset		
I am presently worrying over possible misfortunes		
I feel rested		
I feel anxious		
I feel comfortable		50
I feel self-confident		
I feel nervous		
I am jittery		
I feel 'high strung'		
I am relaxed		55
I feel content		
I am worried		
I feel over excited and 'rattled'		
I feel joyful		
I feel pleasant		60

1 Card (do not punch)

Subject code (do not punch)

History Questionnaire

How long have you had this pain?
(years, months) 61 64

Past Hospital Admissions

DATE	CONDITION	?SURGERY

How many times have you seen your family doctor for pain in the

last month ? 65 66

last year ? 67 68

How many times have you seen your family doctor for other reasons in the

last month ? 69 70

Last year ? 71 72

What other therapists have you seen about your pain in the last year ? 73

What other therapists have you seen about other health problems in the last year 74

Have any of your family members had
Abdominal surgery (1)
Abdominal pain (2)
Both (3)

Mother 75

Father

Spouse

Other ______

______

______ 80

PILOWSKY PRE-OPERATIVE TEST

CARD 2

SUBJECT CODE

Answers, Columns 4-65

Here are some questions about you and your illness.
Put 0 for No and 1 for Yes in Column.

Do you worry a lot about your health? 4

Do you think there is something seriously wrong with your body?

Does your illness interfere with your life a great deal?

Are you easy to get on with when you are ill?

Do you think you are more liable to illness than other people? 8

If the doctor told you that he could find nothing wrong with you, would you believe him?

Is it easy for you to forget about yourself and think about all sorts of other things?

If you feel ill and someone tells you that you are looking better, do you become annoyed?

Do you find that you are often aware of various things happening to your body? 12

Do you ever think of your illness as a punishment for something you have done wrong in the past?

Do you have trouble with your nerves?

If you feel ill or worried, can you be easily cheered up by the doctor?

Do you think that other people realise what its like to be sick? 16

Does it upset you to talk to the doctor about your illness?

Are you bothered by many pains and aches?

Does your illness affect the way you get on with your family or friends a great deal?

Do you find that you get anxious easily? 20

Do you know anybody who has the same illness as you?

Are you more sensitive to pain than other people?

Are you afraid of illness?

Can you express your personal feelings easily to other people? 24

Do people feel sorry for you when you are ill?

Do you think that you worry about your health more than most people?

Do you find that your illness affects your sexual relations? 27

Do you experience alot of pain with your illness?

Except for your illness, do you have any problems?

Do you care whether or not people realise you are sick?

Do you find that you get jealous of other people's good health?

Do you ever have silly thoughts about your health which you can't get out of your mind, no matter how hard you try? 32

Do you ever have any financial problems?

Are you upset by the way people take your illness?

Is it hard for you to believe the doctor when he tells you there is nothing for you to worry about?

Do you often worry about the possibility that you have got a serious illness? 36

Are you sleeping well?

When you are angry, do you tend to bottle up your feelings?

Do you often think that you might suddenly fall ill?

If a disease is brought to your attention (e.g. on TV) do you worry about getting it yourself? 40

Do you feel that people are not taking your illness seriously enough?

Are you upset by the appearance of your face or body?

Do you find that you are bothered by many different symptoms?

Do you frequently try to explain to others how you are feeling? 44

Do you have any family problems?

Do you think there is something the matter with your mind?

Are you eating well?

Is your bad health the biggest difficulty of your life? 48

Do you find that you get sad easily?

Do you worry or fuss over small details that seem unimportant to others?

Are you always a co-operative patient?

Do you often have the symptoms of a very serious disease? 52

Do you find that you get angry easily?

Do you have any work problems?

Do you prefer to keep your feelings to yourself? 55

Do you often find that you get depressed?

Would all your worries be over if you were physically healthy?

Are you more irritable towards other people?

Do you think your symptoms may be caused by worry?

Is it easy for you to let people know when you are cross with them? 60

Is it hard for you to relax?

Do you have personal worries which are not caused by physical illness?

Do you often find that you lose patience with other people?

Is it hard for you to show people your personal feelings?

Does your family have a history of illness? 65

TRIPLE TEST-POST-OPERATIVE

Card 3

SUBJECT CODE

2 3

Answers, Page (Zung) columns 4-23
Page (STAI-XI) columns 24-43
Page (STAI-X2) columns 44-63

<u>Zung</u>

The following are a number of statements about your feelings <u>at the moment</u>. There are no right or wrong answers or trick questions. Do not spend too much time on any one statement. Indicate which best describes how you feel <u>right now</u>.

(1) Never or a little of the time
(2) Some of the time
(3) Good part of the time
(4) Most of the time

e.g. I feel downhearted and blue [1]

* * * * * *

I feel downhearted and blue 4

Morning is when I feel the best

I have crying spells or feel like it

I have trouble sleeping at night

I eat as much as I used to 8

I still enjoy sex

I notice that I am losing weight

I have trouble with constipation

My heart beats faster than usual 12

I get tired for no reason

My mind is as clear as it used to be

I find it easy to do the things I used to

I am restless and can't keep still 16

I feel hopeful about the future

I am more irritable than usual

I find it easy to make decisions

I feel that I am useful and needed 20

My life is pretty full

I feel that others would be better off if I were dead

I still enjoy the things I used to do 23

3 (do not punch) card.

Subject number (do not punch)

STAI-X1

A number of statements which people have used to describe themselves are given below. Read each statement and indicate how you feel <u>right now</u>, that is, at this moment. There are no right or wrong answers. Do not spend too much time on any one statement, give the answer which seems to describe your present feelings best.

Use scale as follows:-

(1) Not at all
(2) Somewhat
(3) Moderately so
(4) Very much so

e.g. I feel happy 4

* * * * * *

Statement	Answer	
I feel calm		24
I feel secure		
I am tense		
I am regretful		
I feel at ease		28
I feel upset		
I am presently worrying over possible misfortunes		
I feel rested		
I feel anxious		32
I feel comfortable		
I feel self-confident		
I feel nervous		
I am jittery		36
I feel 'high strung'		
I am relaxed		
I feel content		
I am worried		40
I feel over excited and 'rattled'		
I feel joyful		
I feel pleasant		43

3 (do not punch)

Subject number (do not punch)

STAI-X2

A number of statements which people have used to describe themselves are given below. Read each statement and then indicate how you generally feel. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe how you generally feel.

Use Scale as follows:-

(1) Almost never
(2) Sometimes
(3) Often
(4) Almost always

e.g. I feel happy | 3 |

* * * * *

I feel pleasant 44

I tire quickly

I feel like crying

I wish I could be as happy as others seem to be

I am losing out on things because I can't make up my mind soon enough 48

I feel rested

I am 'calm, cool and collected'

I feel that difficulties are piling up so that I cannot overcome them

I worry too much over something that really doesn't matter 52

I am happy

I am inclined to take things hard

I lack self-confidence

I feel secure 56

I try to avoid facing a crisis or difficulty

I feel blue

I am content

Some unimportant thought runs through my mind and bothers me

I take disappointments so keenly that I can't put them out of my mind

I am a steady person

I get in a state of tension or turmoil as I think over my recent concerns and interests 63

E P I

CARD 4

1

SUBJECT CODE

2 3

EPI Questions, columns 11-63

In the following questions , answer 0 for NO and 1 for YES.

1. Do you often long for excitement? 11
2. Do you often need understanding friends to cheer you up?
3. Are you usually carefree?
4. Do you find it very hard to take no for an answer?
5. Do you stop and think things over before doing anything? 15
6. If you say you will do something do you always keep your promise, no matter how inconvenient it might be to do so?
7. Does your mood often go up and down?
8. Do you generally do and say things quickly without stopping to think?
9. Do you ever feel "just miserable" for no good reason?
10. Would you do almost anything for a dare? 20
11. Do you suddenly feel shy when you want to talk to an attractive stranger?
12. Once in a while do you lose your temper and get angry?
13. Do you often do things on the spur of the moment?
14. Do you often worry about things you should not have done or said
15. Generally, do you prefer reading to meeting people? 25
16. Are your feelings rather easily hurt?
17. Do you like going out a lot?
18. Do you occasionally have thoughts and ideas that you would not like other people to know about?
19. Are you sometimes bubbling over with energy and sometimes very sluggish?
20. Do you prefer to have few but special friends? 30
21. Do you daydream a lot?
22. When people shout at you, do you shout back?
23. Are you often troubled about feelings of guilt? 33

24. Are all your habits good and desirable ones? 34

25. Can you usually let yourself go and enjoy yourself a lot at a gay party?

26. Would you call yourself tense or 'highly strung'?

27. Do other people think of you as being very lively?

28. After you have done something important, do you often come away feeling you could have done better?

29. Are you mostly quiet when you are with other people?

30. Do you sometimes gossip? 40

31. Do ideas run through your head so that you cannot sleep?

32. If there is something you want to know about, would you rather look it up in a book than talk to someone about it?

33. Do you get palpitations or thumping in your heart?

34. Do you like the kind of work that you need to pay close attention to?

35. Do you get attacks of shaking or trembling? 45

36. Would you always declare everything at the customs, even if you knew that you could never be found out?

37. Do you hate being with a crowd who play jokes on one another?

38. Are you an irritable person?

39. Do you like doing things in which you have to act quickly?

40. Do you worry about awful things that might happen? 50

41. Are you slow and unhurried in the way you move?

42. Have you ever been late for an appointment or work?

43. Do you have many nightmares?

44. Do you like talking to people so much that you never miss a chance of talking to a stranger?

45. Are you troubled by aches and pains? 55

46. Would you be very unhappy if you could not see lots of people most of the time?

47. Would you call yourself a nervous person?

48. Of all the people you know, are there some whom you definitely do not like?

49. Would you say that you were fairly self-confident?

50. Are you easily hurt when people find fault with you or your work?

51. Do you find it hard to really enjoy yourself at a lively party? 61

52. Are you troubled with feelings of inferioritv? 62

53. Can you easily get some life into a rather dull party?

54. Do you sometimes talk about things you know nothing about?

55. Do you worry about your health? 65

56. Do you like playing pranks on others?

57. Do you suffer from sleeplessness? 67

McGILL QUESTIONNAIRE 5

1

Subject Code

2 3

Surgery Code

4 5

McGill Code

6

Page 1 data columns 9-114
Pain location data 15-22

Circle the word which best describes the intensity of the pain you have felt in the following situations:

1. Your pain right now:
   Mild, uncomfortable, distressing, horrible, excruciating 7

2. Your pain at its worst:
   Mild, uncomfortable, distressing, horrible, excruciating 8

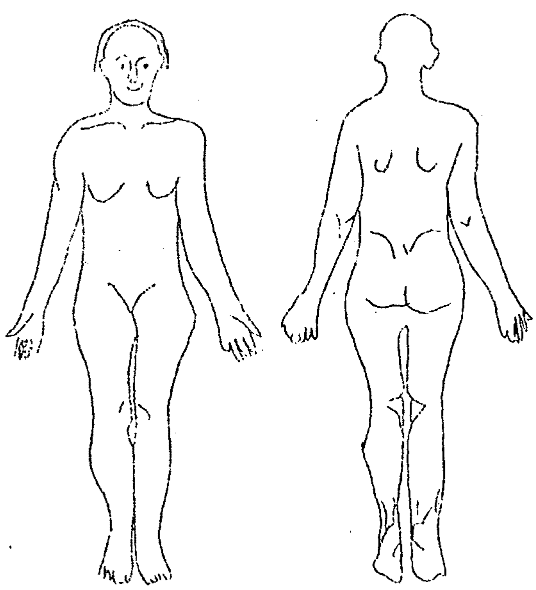
3. Your pain at its least:
   Mild, uncomfortable, distressing, horrible, excruciating 9

4. Worst toothache you have had:
   Mild, uncomfortable, distressing, horrible, excruciating 10

5. Worst headache you have had:
   Mild, uncomfortable, distressing, horrible, excruciating 11

6. Worst stomach pain (prior to operation)
   Mild, uncomfortable, distressing, horrible, excruciating 12

Mark those areas of your body in which you have had pain since your operation.



13

20

(McGill 5Z is Randomised Word List)

LIST CODE (7) COLS 21-23

Some of the words below will describe the pain you have had over the last three days. Answer 0 for NO(THE WORD DOES NOT DESCRIBE MY PAIN) and 1 for YES(THE WORD DOES DESCRIBE MY PAIN). Answer 0(FOR NO) or 1(FOR YES) as often as is appropriate for you; you may find many words which describe your pain or you may find only a few.

1	splitting	( )	COL 24
2	constant	( )	
3	lacerated	( )	
4	scalding	( )	
5	pulling	( )	
6	blinding	( )	
7	taut	( )	
8	drawing	( )	
9	spreading	( )	
10	beating	( )	
11	heavy	( )	
12	crushing	( )	
13	brief	( )	
14	steady	( )	
15	quivering	( )	
16	stabbing	( )	
17	torturing	( )	
18	itchy	( )	
19	suffocating	( )	
20	periodic	( )	
21	smarting	( )	
22	exhausting	( )	
23	lancinating	( )	
24	pulsing	( )	
25	pricking	( )	COL 48

26	rythmic	( )	COL 49
27	radiating	( )	
28	tight	( )	
29	burning	( )	
30	numb	( )	
31	sore	( )	
32	pinching	( )	
33	transient	( )	
34	annoying	( )	
35	flashing	( )	
36	freezing	( )	
37	pounding	( )	
38	tingling	( )	
39	cramping	( )	
40	dreadful	( )	
41	wretched	( )	
42	cruel	( )	
43	nagging	( )	
44	boring	( )	
45	cool	( )	
46	aching	( )	
47	jumping	( )	
48	torturing	( )	
49	agonizing	( )	
50	fearful	( )	
51	searing	( )	
52	frightful	( )	
53	dull	( )	
54	tiring	( )	
55	cutting	( )	
56	gnawing	( )	
57	killing	( )	COL 80

CARD
SUBJECT CODE
SURGERY CODE
MCGILL CODE

58	sickening	( )	COL 7
59	troublesome	( )	
60	punishing	( )	
61	stinging	( )	
62	flickering	( )	
63	hot	( )	
64	shooting	( )	
65	squeezing	( )	
66	tender	( )	
67	drilling	( )	
68	momentary	( )	
69	vicious	( )	
70	throbbing	( )	
71	pressing	( )	
72	tearing	( )	
73	miserable	( )	
74	continuous	( )	
75	wrenching	( )	
76	piercing	( )	
77	tugging	( )	
78	nauseating	( )	
79	gruelling	( )	
80	continuing	( )	
81	cold	( )	
82	penetrating	( )	
83	terrifying	( )	
84	intense	( )	
85	intermittent	( )	
86	unbearable	( )	
87	rasping	( )	COL 36

ANALGESIC TRIAL	0 1
Subject Code	2 3
Surgery Code	4 5
Medical Code	M 6
STICK IDENTIFICATION LABEL HERE	
Weight (Kg) - - - - - - -	7 9
Height (cm) - - - - - - -	10 12
Operation ______________________	13
Pre-Operative A.S.A. Status ____________	14
Pre-operative Drug Therapy ____________ ____________ ____________ ____________	15 16
Pre-Medication ____________ ____________	17
Time of Pre-Medication	18 21
Time of Anaesthetic Induction	22 25
Anaesthetic General/Epidural/Spinal	26
Intra-operative Agents - Inhalational/Opoid/Other	27
Relaxant Used Non-Depolarising/Depolarising/Both	28
Anaesthetic Finish Time	29 32

Date of Surgery | 33–38

Post-Operative Cardio-Respiratory Status | 39

* * *

First 24 hours (from end of Anaesthesia)

1 = Morphine, 2 = Pethidine, 3 = Omnopon,
4 = Buprenorphine, 5 = Other | 40

Times of Analgesic Administration

41–44 | 45–48 | 49–52

53–56 | 57–60 | 61–64

Mg of Analgesic in this period | 65–67

Antiemetic
(1 = Prochlorperazine, 2 Metaclopramide,
3 = Droperidol, 4 = Other) | 68

Mg. of Antiemetic in this period | 69 70

Time of EMG Measurements | 71–74

Biofeedback given | 75

Patient in Ward | 76 77

ANALGESIC TRIAL

0
1

Subject Code

2	3

Surgery Code

4	5

Medical Code

N

* * *

2nd 24 hours (from end of Anaesthesia)

1=Morphine, 2= Pethidine, 3= Omnopon, 4= Buprenorphine
5=Other

7

Times of Analgesic Administration

8	-		11	12	-		15	16	-		19
20	-		23	24	-		27	28	-		31

Mg. of Analgesic in this period

32	-	34

Antiemetic
(1 = Prochlorperazine, 2 = Metaclopramide, 3 = Droperidol
4 = Other)

35

Mg. of Antiemetic in this period

36	37

Time of EMG measurements

38		-	41

Biofeedback given

42

* * *

3rd 24 hours (from end of Anaesthesia)

1 = Morphine, 2 = Pethidine, 3 = Omnopan, 4 = Buprenorphine, 5 = Other

43

Times of Analgesic Administration

44 - 47 48 - 51 52 - 55

56 - 59 60 - 63 64 - 67

Mg of Analgesic in this period

68 - 70

Antiemetic

(1 = Prochlorperazine, 2 = Metaclopramide, 3 = Droperidol 4 = Other)

71

Mg of Antiemetic in this period

72 73

Time of EMG measurements

74 - 77

Biofeedback given

78

* * *

ANALGESIC TRIAL

Subject Code		2 3
Surgery Code		4 5
Medical Code		P (6)

(Card column 1: 0)

Day of Operation (expected times - approximately 1300, 1700 and 2100)	TIME	7–10
	SCORE	11 12
	TIME	13–16
	SCORE	17 18
	TIME	19–22
	SCORE	23 24
Day 1 (After op.) (expected times - approximately 900, 1300, 1700 and 2100 hrs.)	TIME	25–28
	SCORE	29 30
	TIME	31–34
	SCORE	35 36
	TIME	37–40
	SCORE	41 42
	TIME	43–46
	SCORE	47 48

Day 2 (900, 1300, 1700 and 2100 hrs.)	TIME	49 52
	SCORE	53 54
	TIME	55 58
	SCORE	59 60
	TIME	61 64
	SCORE	65 66
	TIME	67 70
	SCORE	71 72
Day 3 (900 hrs. only)	TIME	73 76
	SCORE	77 78

PATIENT QUESTIONNAIRE

1. What are your feelings about taking part in this trial?

2. Has this study interfered with your normal ward routine or seeing visitors?

3. Have the relaxation techniques been helpful?

4. Comments:

APPENDIX 2: COMPUTER PROGRAMME FOR TEST MARKING. J.E. WELLS

```
C         PROGRAMME TO PROCESS MARGARET MOON'S DATA, TO STORE
C         PROCESSED DATA IN FILES MOONEXA.DAT(AB.HYST),MOONEXV.DAT(VAG.HYST),
C         AND MOONEXC(COLECYST) FOR EXPTL DATA AND IN FILES MOONCTLA.DAT,
C         MOONCTLV.DAT, AND MOONCTLC/DAT FOR CONTROL DATA, AND TO PRINT
C         SUMMARIES FOR EACH SUBJECT FROM FILE SUMMARY.DAT
C         ALL EXPTL DATA FILES SHARE THE SAME FORMAT
C         ALL CTL DATA FILES SHARE THE SAME FORMAT WHICH IS THAT FOR EXPTLS
C         MINUS THE RECORDS USED TO STORE EMG DATA
C
C         MISSING RESPONSES IN PSYCHOLOGICAL TESTS RESULT IN PRORATED RESPONSES
C         WITH THE NUMBER OF MISSING RESPONSES INDICATED
C
          INTEGER T(62),SCORE,SCALE(7),D(70),ST(4)
          DIMENSION DR(2,3),NMISS(8)
          INTEGER*4 NO
          COMMON/BLK1/T
          OPEN (UNIT=1,NAME='SUMMARY.DAT',TYPE='NEW')
          OPEN (UNIT=5,NAME='CARDS.DAT',TYPE='OLD')
C
C         CARD 1
 98       READ (5,100,END=97) NC,NS,NO,G,S,((DR(I,J),J=1,3),I=1,2),
         1(D(J),J=1,6),(T(J),J=1,20),(D(J),J=7,19)
 100      FORMAT(I1,A2,I6,2A1,2(2A4,A3),I2,25I1,I4,4I2,8I1)
C         CHECK CARD IS CORRECT ONE
          IF(NC.EQ.1) GO TO 1
          NN=1
          WRITE(1,101)NS,NC,NN
 101      FORMAT('0','FOR SUBJECT',A3,' CARD',I3,' READ WHEN CARD',I2,
         1' EXPECTED')
          GO TO 2
C         MARK STAI-X1
 1        CALL STAIX1(SCORE,MISS)
          IF(G.EQ.'Z') GO TO 11
          IF(S.EQ.'A') OPEN(UNIT=2,NAME='MOONEXA.DAT',TYPE='UNKNOWN',
         1ACCESS='APPEND',CARRIAGECONTROL='LIST')
          IF(S.EQ.'V') OPEN(UNIT=2,NAME='MOONEXV.DAT',TYPE='UNKNOWN',
         1ACCESS='APPEND',CARRIAGECONTROL='LIST')
          IF(S.EQ.'C') OPEN(UNIT=2,NAME='MOONEXC.DAT',TYPE='UNKNOWN',
         1ACCESS='APPEND',CARRIAGECONTROL='LIST')
          GO TO 12
 11       IF(S.EQ.'A') OPEN(UNIT=2,NAME='MOONCTLA.DAT',TYPE='UNKNOWN',
         1ACCESS='APPEND',CARRIAGECONTROL='LIST')
          IF(S.EQ.'V') OPEN(UNIT=2,NAME='MOONCTLV.DAT',TYPE='UNKNOWN',
         1ACCESS='APPEND',CARRIAGECONTROL='LIST')
          IF(S.EQ.'C') OPEN(UNIT=2,NAME='MOONCTLC.DAT',TYPE='UNKNOWN',
         1ACCESS='APPEND',CARRIAGECONTROL='LIST')
 12       WRITE(2,102)NS,NO,G,S,((DR(I,J),J=1,3),I=1,2),(D(J),J=1,6),
         1SCORE,MISS,(D(J),J=7,19)
 102      FORMAT(A2,I6,2A1,2(2A4,A3),I2,5I1,2I2,I4,4I2,8I1)
          WRITE(1,103)NS
 103      FORMAT('1','SUBJECT',A3)
          IF(G.EQ.'F')WRITE(1,104)
          IF(G.EQ.'H')WRITE(1,105)
          IF(G.EQ.'Z')WRITE(1,106)
 104      FORMAT('+',15X,'FEEDBACK')
 105      FORMAT('+',15X,'NO FEEDBACK')
 106      FORMAT('+',15X,'CONTROL')
          IF(S.EQ.'A') WRITE(1,107)
          IF(S.EQ.'V') WRITE(1,108)
          IF(S.EQ.'C') WRITE(1,109)
 107      FORMAT('+',30X,'ABDOMINAL HYSTERECTOMY')
 108      FORMAT('+',30X,'VAGINAL HYSTERECTOMY')
 109      FORMAT('+',30X,'COLECYSTECTOMY')
          WRITE(1,110) D(1),D(4)
 110      FORMAT('0','AGE',I3/'0','THERAPIST PREDICTION OF PAIN
         1TOLERANCE',I2)
          IF(D(6).EQ.0) WRITE(1,111)
          IF(D(6).EQ.1) WRITE(1,112)
 111      FORMAT('0','PAIN DID NOT LEAD TO OPERATION'/)
 112      FORMAT('0','PAIN LED TO OPERATION'/)
          WRITE(1,113) SCORE,MISS
 113      FORMAT('0','PRE-OP STATE ANXIETY (STAI-X1)', I4,'    NO. OF
         1MISSING RESPONSES',I3/)
C
C         CARD 2
 2        READ(5,114,END=99) NC,NSF,(T(J),J=1,62)
 114      FORMAT(I1,A2,62I1)
          IF(NC.EQ.2) GO TO 21
          NN=2
          WRITE(1,101)NS,NC,NN
          GO TO 3
 21       IF(NSF.EQ.NS)GO TO 22
          WRITE(1,115) NC,NSF,NS
 115      FORMAT('0','CARD',I3,' CONTAINS DATA FROM SUBJECT',A3,' WHEN
         1 DATA FROM SUBJECT',A3,' EXPECTED')
          GO TO 3
C         INSERT Q62 IN CORRECT PLACE AS Q5 AND ADJUST OTHER QN NOS
 22       D(5)=T(62)
          DO 23 I=5,61
 23       D(I+1)=T(I)
          DO 24 I=5,62
 24       T(I) = D(I)
C         MARK PILOWSKY QUESTIONNAIRE
          CALL PILOWS(SCALE,NMISS,FUNCTN,MISTOT)
          WRITE(2,116) (SCALE(I),I=1,7),(NMISS(I),I=1,7),FUNCTN,MISTOT
 116      FORMAT(14I2,F7.2,I2)
          WRITE(1,117) (SCALE(I),I=1,7),(NMISS(I),I=1,7),FUNCTN,MISTOT
 117      FORMAT('0','PILOWSKY"S IBQ      SCALE SCORES',7I4/' ',
         1'      MISSING RESPONSES PER SCALE',7I4/' ',
         118X,'FUNCTION SCORE',F7.2,' TOTAL NO. OF MISSING RESPONSES',I3/)
C
```

```
C             CARD 3
3             READ(5,118,END=99)NC,NSF,(T(I),I=1,20),(D(I),I=1,40)
118           FORMAT(I1,A2,60I1)
              IF(NC.EQ.3)GO TO 31
              NN=3
              WRITE(1,101)NS,NC,NN
              GO TO 4
31            IF(NSF.EQ.NS) GO TO 32
              WRITE(1,115)NC,NSF,NS
              GO TO 4
C             MARK ZUNG
32            CALL ZUNG(SCORE,MISS)
C             MARK STAI-X1
              DO 33 I=1,20
33            T(I) = D(I)
              CALL STAIX1(NSCORE,NMIS)
C             MARK STAI-X2
              DO 34 I=1,20
34            T(I) = D(I+20)
              CALL STAIX2(MSCORE,MMISS)
              WRITE(2,119)SCORE,MISS,NSCORE,NMIS,MSCORE,MMISS
119           FORMAT(6I4)
              WRITE(1,120) SCORE,NSCORE,MSCORE,MISS,NMIS,MMISS
120           FORMAT('0','POST-OP SCORES        ZUNG=',I3,'    STAI-X1=',
              1I3,'     STAI-X2=',I3/' ','NO. OF MISSING RESPONSES',T28,I3,
              1T42,I3,T57,I3/)
C
C             CARD 4
4             READ(5,121,END=99) NC,NSF,(T(I),I=1,57)
121           FORMAT(I1,A2,7X,57I1)
              IF(NC.EQ.4) GO TO 41
              NN=4
              WRITE(1,101)NS,NC,NN
              GO TO 5
41            IF(NSF.EQ.NS) GO TO 42
              WRITE(1,115)NC,NSF,NS
              GO TO 5
C             MARK EPI
42            CALL EPI(NE,NN,NL,NMISS)
              WRITE(2,119) NE,NN,NL,(NMISS(I),I=1,3)
              WRITE(1,122) NE,NN,NL,(NMISS(I),I=1,3)
122           FORMAT('0','EPI SCORES        E=',I3,'    N=',I3,'    L=',I3/
              1' ','MISSING RESPONSES',T20,I3,T28,I3,T36,I3/)
C
C             CARD 5Y
5             READ(5,123,END=99) NC,NSF,NM,(D(J),J=1,14),LN,(T(J),J=1,57)
123           FORMAT(I1,A2,2X,A1,14I1,I3,57I1)
              MM='Y'
              NE=5
              IF(NC.EQ.5.AND.NM.EQ.MM) GO TO 51
              WRITE(1,124) NS,NC,NM,NE,MM
124           FORMAT('0','FOR SUBJECT',A3,' CARD',I3,A1,' WHERE CARD',I2,A2,'
              1 SHOULD BE')
              GO TO 55
51            IF(NSF.EQ.NS) GO TO 53
              WRITE(1,125) NC,NM,NSF,NS
125           FORMAT('0','CARD',I3,A1,' CONTAINS DATA FROM SUBJECT',A3,
              1' WHEN DATA FROM SUBJECT',A3,' EXPECTED')
              GO TO 55
53            WRITE(2,126) (D(J),J=1,14),LN,(T(J),J=1,57)
126           FORMAT(14I1,I3,57I1)
              WRITE(1,127) (D(J),J=1,6)
127           FORMAT('0','PAIN INTENSITY SCORES',6I5/)
C
C             CARD 5Z
55            READ(5,128,END=99) NC,NSF,NM,(T(J),J=1,30)
128           FORMAT(I1,A2,2X,A1,30I1)
              MM='Z'
              IF(NC.EQ.5.AND.NM.EQ.MM) GO TO 56
              WRITE(1,124)NS,NC,NM,NE,MM
              GO TO 6
56            IF(NSF.EQ.NS) GO TO 57
              WRITE(1,125) NC,NM,NSF,NS
              GO TO 6
57            WRITE(2,129) (T(J),J=1,30)
129           FORMAT(30I1)
C
6             IF(G.EQ.'Z') GO TO 15
C
C             EMG CARDS 6F,6A,....9A
              DO 61 I=1,4
              DO 62 J=1,2
              READ(5,130,END=99) NC,NSF,NM,(T(K),K=1,20),ST(I)
130           FORMAT(I1,A2,2X,A1,5(2X,4I3),I4)
              IF(J.EQ.1) MM='F'
              IF(J.EQ.2) MM='A'
              IF(NC.EQ.(I+5).AND.NM.EQ.MM) GO TO 63
              NE=I+5
              WRITE(1,124) NS,NC,NM,NE,MM
              GO TO 62
63            IF(NSF.EQ.NS) GO TO 64
              WRITE(1,125)NC,NM,NSF,NS
              GO TO 62
64            IF(ST(I).EQ.0) ST(I)=1401
              WRITE(2,131) (T(K),K=1,20),ST(I)
131           FORMAT(20I3,I4)
62            CONTINUE
61            CONTINUE
C
```

```
C
C       CARD 0 D
15      READ(5,132,END=99) NC,NSF,NM,(T(I),I=1,12)
132     FORMAT(I1,A2,2X,A1,3X,4(3I3,2X))
        MM = 'D'
        NE=0
        IF(NC.EQ.0.AND.NM.EQ.MM) GO TO 70
        WRITE(1,124) NS,NC,NM,NE,MM
        GO TO 16
70      IF(NSF.EQ.NS) GO TO 71
        WRITE(1,125)NC,NM,NSF,NS
        GO TO 16
C       SUM LU AND UR DISTENTION SCORES
71      J=1
        DO 72 I=1,4
        D(I) = T(J) + T(J+1)
72      J=J+3
        WRITE(1,133) (T(I),I=3,12,3), (D(I),I=1,4)
133     FORMAT('0','DAILY LR DISTENTION' T25,4I5/' ','DAILY LUP
       1DISTENTION',T25,4I5/)
        WRITE(2,134) (T(I),I=1,12)
134     FORMAT(12I3)
16      CONTINUE
C
C       CARD 0 M
        READ(5,135,END=99) NC,NSF,NM,(T(I),I=1,27)
135     FORMAT(I1,A2,2X,A1,2I3,2I1,I2,I1,2I4,3I1,I4,3I2,2I1,
       16I4,I3,I1,I2,5X,I2)
        MM='M'
        IF(NC.EQ.0.AND.NM.EQ.MM) GO TO 80
        WRITE(1,124)NS,NC,NM,NE,MM
        GO TO 17
80      IF(NSF.EQ.NS) GO TO 81
        WRITE(1,125) NC,NM,NSF,NS
        GO TO 17
81      IF(T(17).EQ.0) EMG=0.
        IF(T(17).EQ.1) EMG = T(24)
        IF(T(17).EQ.2) EMG = T(24)*.1
        IF(T(17).EQ.3.OR.T(17).EQ.6.OR.T(17).EQ.7) EMG = T(24)*.5
        IF(T(17).EQ.4) EMG = T(24)*33.33
        IF(T(17).EQ.5.OR.T(17).GT.8) EMG = 9999.9
        IF(T(17).EQ.8) EMG = 0.
        WRITE(1,136) T(17),T(24),EMG
136     FORMAT('0','1ST 24 HRS        DRUG',I3,'  MG',I4,'  EQUIVALENT
       1 MG OF MORPHINE',F7.1)
        IF(T(17).EQ.8) WRITE(1,166)
166     FORMAT(' ','NOTE THAT MG OF DRUG 8 ARE REALLY 10*GRAMS OF
       1SIMPLE ANALGESIC')
        WRITE(2,137) (T(I),I=1,27),EMG
137     FORMAT(2I3,2I1,I2,I1,2I4,3I1,I4,3I2,2I1,6I4,I3,I1,I2,I2,F7.1)
C
C       CARD 0 N
17      READ(5,138,END=99) NC,NSF,NM,(T(I),I=1,20)
138     FORMAT(I1,A2,2X,A1,I1,6I4,I3,I1,I2,5X,I1,6I4,I3,I1,I2)
        MM='N'
        IF(NC.EQ.0.AND.NM.EQ.MM) GO TO 82
        WRITE(1,124) NS,NC,NM,NE,MM
        GO TO 18
82      IF(NSF.EQ.NS)GO TO 83
        WRITE(1,125) NC,NM,NSF,NS
        GO TO 18
83      IF(T(1).EQ.0) EMG=0.
        IF(T(1).EQ.1) EMG=T(8)
        IF(T(1).EQ.2) EMG = T(8)*.1
        IF(T(1).EQ.3.OR.T(1).EQ.6.OR.T(1).EQ.7) EMG = T(8)*.5
        IF(T(1).EQ.4) EMG = T(8)*33.33
        IF(T(1).EQ.5.OR.T(1).GT.8) EMG = 9999.9
        IF(T(1).EQ.8) EMG = 0.
        IF(T(11).EQ.0) EM=0.
        IF(T(11).EQ.1) EM=T(18)
        IF(T(11).EQ.2) EM = T(18)*.1
        IF(T(11).EQ.3.OR.T(11).EQ.6.OR.T(11).EQ.7) EM = T(18)*.5
        IF(T(11).EQ.4) EM = T(18)*33.33
        IF(T(11).EQ.5.OR.T(11).GT.8) EM = 9999.9
        IF(T(11).EQ.8) EM = 0.
        WRITE(1,139) T(1),T(8),EMG,T(11),T(18),EM
139     FORMAT(' ','2ND 24 HRS        DRUG',I3,'  MG',I4,'  EQUIVALENT
       1MG OF MORPHINE',F7.1/' ','3RD 24 HRS        DRUG',I3,'  MG',I4,
       1'  EQUIVALENT MG OF MORPHINE',F7.1/)
        IF(T(1).EQ.8.OR.T(11).EQ.8) WRITE(1,166)
        WRITE(2,140), (T(I),I=1,20),EMG,EM
140     FORMAT(I1,6I4,I3,I1,I2,I1,6I4,I3,I1,I2,2F7.1)
C
C       CARD 0 P
18      READ(5,141,END=99) NC,NSF,NM,(T(I),I=1,24)
141     FORMAT(I1,A2,2X,A1,12(I4,I2))
        MM='P'
        IF(NC.EQ.0.AND.NM.EQ.MM) GO TO 84
        WRITE(1,124) NS,NC,NM,NE,MM
        GO TO 95
84      IF(NSF.EQ.NS) GO TO 85
        WRITE(1,125) NC,NM,NSF,NS
        GO TO 95
85      WRITE(1,142) (T(I),I=1,24)
142     FORMAT('0','ANALOGUE SCORES       TIME & SCORE'/' ',
       1'DAY OF OP',T12,3(I7,I3)/' ','DAY 1',T12,4(I7,I3)/
       1' ','DAY 2',T12,4(I7,I3)/' ','DAY 3',T12,I7,I3)
        WRITE(2,143) (T(I),I=1,24)
143     FORMAT(12(I4,I2))
95      CLOSE (UNIT=2)
        GO TO 98
99      WRITE(1,150)NS
150     FORMAT('0','LAST CARD READ NOT LAST DATA CARD FOR SUBJECT',A3,
       1'DELETE THE INCOMPLETE DATA FOR THIS S FROM APPROPRIATE FILE')
        CLOSE(UNIT=2)
97      CLOSE(UNIT=1)
        CLOSE(UNIT=5)
        STOP
        END
```

```
                  SUBROUTINE EPI(E,N,L,NMISS)
       C          THIS SUBROUTINE MARKS THE EYSENCK PERSONALITY INVENTORY FORM A
       C          INPUT - 57 TEST RESPONSES    OUTPUT - E,N, AND L SCORES PLUS
       C          NUMBER OF MISSING RESPONSES FOR EACH SCALE
       C          SCALE SCORES ARE PRORATED IF THERE ARE MISSING RESPONSES
       C          MISSING RESPONSES MUST BE CODED AS 9
                  INTEGER T,E,S(57)
                  DIMENSION NMISS(3)
                  COMMON/BLK1/T(57)
       C          ARRAY S INDICATES THE RELEVANT SCORING FOR EACH ITEM
       C          1 - E SCALE YES(1) TO SCORE       2 - E SCALE NO(0) TO SCORE
       C          3 - N SCALE YES(1) TO SCORE  N.B. ALL N ITEMS SCORE ON YES
       C          4 - L SCALE YES(1) TO SCORE       5 - L SCALE NO(0) TO SCORE
                  DATA S/1,3,1,3,2,4,3,1,3,1,3,5,1,3,2,3,1,5,3,2,3,1,3,4,1,3,1,
                  13,2,5,3,2,3,2,3,4,2,3,1,3,2,5,3,1,3,1,3,5,1,3,2,3,1,5,3,1,3/
                  E = 0
                  N = 0
                  L = 0
                  DO 3 I=1,3
       3          NMISS(I)=0
                  DO 1 I=1,57
                  IF(T(I).NE.9) GO TO 2
                  IF(S(I).EQ.1.OR.S(I).EQ.2) NMISS(1) = NMISS(1) + 1
                  IF(S(I).EQ.3) NMISS(2) = NMISS(2) + 1
                  IF(S(I).EQ.4.OR.S(I).EQ.5) NMISS(3) = NMISS(3) + 1
                  GO TO 1
       2          IF (S(I).EQ.1) E = E + T(I)
                  IF (S(I).EQ.2) E = E + (1 - T(I))
                  IF (S(I).EQ.3) N = N + T(I)
                  IF (S(I).EQ.4) L = L + T(I)
                  IF (S(I).EQ.5) L = L + (1 - T(I))
       1          CONTINUE
       C          PRORATE FOR MISSING ITEMS
                  A = 24./(24.-NMISS(1))
                  B = 24./(24.-NMISS(2))
                  C = 9./(9.-NMISS(3))
                  E = E*A
                  N = N*B
                  L = L*C
                  RETURN
                  END
```

```
                  SUBROUTINE ZUNG(SCORE,N)
       C          THIS SUBROUTINE MARKS ZUNG'S SYMPTOMS OF DEPRESSION SCALE (SDS)
       C          INPUT - 20 TEST RESPONSES (T)      OUTPUT - ONE SCORE PLUS N
       C          N IS THE NUMBER OF MISSING RESPONSES
       C          THE SCORE IS PRORATED IF THERE ARE MISSING RESPONSES
       C          MISSING RESPONSES MUST BE CODED AS 9
                  INTEGER T,SCORE,R(20)
                  COMMON/BLK1/T(20)
       C          ARRAY R INDICATES WHETHER OR NOT TO REVERSE SCORING
       C          0 - O.K.     1 - REVERSE
                  DATA R/0,1,0,0,1,1,4*0,1,1,0,1,0,3*1,0,1/
                  SCORE = 0
                  N=0
                  DO 1 I=1,20
       C          CHECK FOR MISSING RESPONSES
                  IF(T(I).NE.9) GO TO 2
                  N=N+1
                  GO TO 1
       2          IF(R(I).EQ.1) T(I) = 5 - T(I)
                  SCORE = SCORE + T(I)
       1          CONTINUE
       C          ADJUSTMENT FOR MISSING RESPONSES
                  A = 20./(20.-N)
                  SCORE = SCORE*A
       C          SCALE FROM 20-80 TO 25-100, AS DONE BY ZUNG
                  SCORE = SCORE*1.25
                  RETURN
                  END
```

```
      SUBROUTINE STAIX1(SCORE,N)
C     THIS SUBROUTINE MARKS THE A-STATE SCALE (FORM X-1) OF
C     THE STATE-TRAIT ANXIETY INVENTORY (STAI)
C     INPUT - 20 TEST RESPONSES (T)      OUTPUT - ONE SCORE PLUS N
C     N IS THE NUMBER OF MISSING RESPONSES
C     THE SCORE IS PRORATED IF THERE ARE MISSING RESPONSES
C     MISSING RESPONSES MUST BE CODED AS 9
      INTEGER T,SCORE
      COMMON/BLK1/T(20)
      SCORE = 0
      N=0
      DO 1 I=1,20
C     CHECK FOR MISSING RESPONSES (CODED AS 9)
      IF(T(I).NE.9) GO TO 3
      N=N+1
      GO TO 1
C     REVERSE SCORING FOR REVERSED ITEMS
3     IF (I.EQ.3.OR.I.EQ.4.OR.I.EQ.6.OR.I.EQ.7.OR.I.EQ.9.OR.I.EQ.12.
     1OR.I.EQ.13.OR.I.EQ.14.OR.I.EQ.17.OR.I.EQ.18) GO TO 2
      T(I) = 5 - T(I)
C     SUM SCORES
2     SCORE = SCORE + T(I)
1     CONTINUE
C     ADJUSTMENT FOR MISSING RESPONSES
      A=20./(20.-N)
      SCORE = SCORE*A
      RETURN
      END
```

```
      SUBROUTINE STAIX2(SCORE,N)
C     THIS SUBROUTINE MARKS THE A-TRAIT SCALE (FORM X-2) OF THE
C     STATE-TRAIT ANXIETY INVENTORY (STAI)
C     INPUT - 20 TEST RESPONSES (T)      OUTPUT - ONE SCORE PLUS N
C     N IS THE NUMBER OF MISSING RESPONSES
C     THE SCORE IS PRORATED IF THERE ARE MISSING RESPONSES
C     MISSING RESPONSES MUST BE CODED AS 9
      INTEGER T,SCORE
      COMMON/BLK1/T(20)
      SCORE = 0
      N=0
      DO 1 I=1,20
C     CHECK FOR MISSING RESPONSES (CODED AS 9)
      IF(T(I).NE.9) GO TO 3
      N=N+1
      GO TO 1
C     REVERSE SCORING FOR REVERSED ITEMS
3     IF(I.EQ.1.OR.I.EQ.6.OR.I.EQ.7.OR.I.EQ.10.OR.I.EQ.13.OR.I.EQ.
     116.OR.I.EQ.19) GO TO 4
      GO TO 2
4     T(I) = 5 - T(I)
C     SUM SCORES
2     SCORE = SCORE + T(I)
1     CONTINUE
C     ADJUSTMENT FOR MISSING RESPONSES
      A=20./(20.-N)
      SCORE = SCORE*A
      RETURN
      END
```

```
FORTRAN IV-PLUS V02-51D          14:12:28      20-APR-81              PAGE 1
PILOWS.FTN       /TR:BLOCKS/WR

0001                  SUBROUTINE PILOWS(SCALE,NMISS,FUNCTN,MISTOT)
            C         THIS SUBROUTINE MARKS PILOWSKY'S ILLNFSS BEHAVIOR
            C         QUESTIONNAIRE (IBQ)
            C         INPUT - 62 TEST RESPONSES (T)      OUTPUT - 7 SCALE SCORES (SCALE),
            C         THE NO. MISSING RESPONSES PER SCALE, PLUS 1 DISCRIMINANT FUNCTION SCORE (FUNCTN)
            C         AND THE TOTAL NUMBER OF MISSING RESPONSES OVER THE SEVEN SCALES
0002                  INTEGER T,SCALE(8),S(62)
0003                  COMMON/BLK1/T(62)
0004                  DIMENSION NMISS(8)
            C         SCALE(8) IS FOR FILLER ITEMS
            C         ARRAY S CONTAINS THE RELEVANT SCALE FOR EACH ITEM
0005                  DATA S/8,2,2,7,8,8,2,8,1,2,3,5,8,8,8,3,7,5,8,1,1,4,8,1,8,8,6,8,
                      11,1,6,1,8,8,2,4,1,1,8,8,2,8,6,3,8,3,5,8,8,8,7,8,4,5,6,7,3,4,5,6,7,4/
0006                  DO 20 J=1,8
0007                  NMISS(J) = 0
0008        20        SCALE(J) = 0
0009                  DO 10 I=2,62
            C         CHECK FOR MISSING RESPONSES (CODED AS 9)
0010                  IF (T(I).NE.9) GO TO 1
0011                  J = S(I)
0012                  NMISS(J) = NMISS(J) + 1
0013                  GO TO 10
            C         REVERSE SCORE FOR REVERSE ITEMS
0014        1         IF(I.EQ.4.OR.I.EQ.7.OR.I.EQ.16.OR.I.EQ.22.OR.I.EQ.27.OR.I
                      1.EQ.31.OR.I.EQ.35.OR.I.EQ.43.OR.I.EQ.46.OR.I.EQ.58.OR.I.EQ
                      1.60) T(I) = 1 - T(I)
            C         SORT OUT ITEMS TO SCALES
0015                  J = S(I)
0016                  SCALE(J) = SCALE(J) + T(I)
0017        10        CONTINUE
            C         PRORATING SCALES IF NECESSARY AND SUMMING MISSING RESPONSES
0018                  MISTOT = 0
0019                  DO 2 I=1,7
0020                  IF (NMISS(I).EQ.0) GO TO 2
0021                  XN = 5.
0022                  IF (I.EQ.1) XN = 9.
0023                  IF (I.EQ.2) XN = 6.
0024                  A = XN/(XN-NMISS(I))
0025                  SCALE(I) = SCALE(I)*A
0026                  MISTOT = MISTOT + NMISS(I)
0027        2         CONTINUE
0028                  FUNCTN = 10.*SCALE(3) - 4.0173*SCALE(2) -4.1160*SCALE(6)
                      1 -2.6486*SCALE(7) + 57.926
0029                  RETURN
0030                  END
```

Age was not included in this programme on Scale 7. Adjustments were made for age in Scale 7 and the Discriminant Function score at a later stage.

APPENDIX 3: DICTIONARY OF VARIABLES AND ABBREVIATIONS

DICTIONARY OF VARIABLES AND ABBREVIATIONS

AFDIST	Affective disturbance - scale 5 of IBQ
AFINHIB	Affective inhibition - scale 4 of IBQ
AIBQ	Abnormal Illness Behaviour - 4 scales of IBQ
AGE	Age
DENIAL	Denial - scale 6 of IBQ
DEPRESS	Depression - Zung Self-Rating Scale (SRS)
DISCONV	Disease Conviction - scale 2 of IBQ
DISTEND	Distension; abdominal measure
EMG	Electromyograph
EPI	Eysenck Personality Inventory
FACTOR 1	Emotional disturbance; Factor 1 of McGill adjective list.
EXTRAVER	Extraversion; scale of EPI
FEEDBACK	Feedback of analogue tone of EMG
FIRSURG	First surgical operation for subject
FOREHO	EMG measure on forehead on pre-operative day.
FOREHI	EMG measure on forehead, first post-operative day.
FOREH2	EMG measure on forehead, second post-operative day.
FOREH3	EMG measure on forehead, third post-operative day.
FOREHT	Total EMG from forehead across four days.
FRONTO	See FOREHO
HYPOCHON	Hypochondriasis, scale 1 of IBQ
IBQ	Illness Behaviour Questionnaire, Pilowsky
IRRITAB	Irritability, scale 7 of IBQ
LIE	Lie, scale of EPI
NEUROTIC	Neurotic, scale of EPI.
PAIN	Pain measured on visual analogue scale,
PAIN ANALOGUE	averaged and transformed.
PAIN FACTOR	Factor 1, emotional disturbance.
PAINLS	Pain lead to the subject's decision to have surgery.
PSYCHOSOM	Psychological vs somatic functioning, scale 3 IBQ.
RECTO	Rectus Abdominis EMG, pre-operative day.
RELAX	Measure of Relaxation Behaviour.
RELAXGRP	see RELAX
SDS	Zung self-rating depression scale
STATE	State Anxiety, measured on STAI-XI
TRAIT	Trait Anxiety, measured on STAI-X2
UT	Total Morphine, in equivalent grams of morphine.
UTW	Total Morphine/per 70 grams of body weight.

APPENDIX 4: ANOVA TABLES

FIRST ANOVA

Source	DF	Sums of Squares	Mean Square	F-Ratio	Significance
Between Ss					
F	1	24.8	24.8	0.825	NS
O	1	26.6	26.6	0.885	NS
FO	1	.166	.116	0.005	NS
S:OF	32	961.7	30.5		
Within Ss					
M	1	1692.2	1692.2	81.7	<0.0001
FM	1	137.9	137.9	6.639	0.0147
OM	1	5.4	5.4	0.26	NS
FOM	1	18.3	18.3	0.881	NS
MS:OF	32	664.6	20.769		
T	19	6.9	0.363	1.069	NS
FT	19	8.7	0.488	1.409	0.115
OT	19	8.6	0.453	1.393	NS
FOT	19	3.7	0.195	0.599	NS
TS:OF	608	197.8	0.325		
MT	19	5.7	0.3	1.039	NS
FMT	19	16.6	0.87	3.025	<0.0001
OMT	19	3.1	0.163	0.565	NS
FOMT	19	4.7	0.247	0.856	NS
MTS:OF	608	175.6	0.289		

SECOND ANOVA

Source	DF	Sums of Squares	Mean Square	F-Ratio	Significance
Between Ss					
O	1	115.204	115.204	1.538	0.22
F	1	140.625	140.625	1.878	0.18
OF	1	3.64	3.64	0.049	NS
S:OF	32	2395.7	74.866		
Within Ss					
D	3	163.889	54.63	4.22	0.007
FD	3	64.588	21.53	1.663	0.18
OD	3	69.778	23.26	1.797	0.153
FOD	3	34.606	11.54	0.891	NS
DS:OF	96	1242.781	12.94		
M	1	4541.5	4541.5	99.944	<0.0001
FM	1	171.9	171.0	3.784	0.06
OM	1	0.17	0.17	0.004	NS
FOM	1	13.88	13.88	0.306	NS
MS:OF	32	1454.09	45.44		
DM	3	107.69	35.89	2.992	0.035
FDM	3	64.54	21.51	1.793	0.15
ODM	3	34.32	11.44	0.954	NS
FODM	3	13.32	4.44	0.37	NS
DMS:OF	96	1151.68	11.99		
Within Cells					
R:OFDMS	5472	2719.51	0.497		
Total	5759				

THIRD ANOVA

Source	DF	Sums of Squares	Mean Square	F-Ratio	Significance
Between Ss					
O	1	53.2	53.2	0.543	NS
F	1	311.8	311.8	3.182	.084
OF	1	15.9	15.9	0.162	NS
S:OF	32	3135.8	97.99		
Within Ss					
D	3	255.4	85.1	4.07	0.009
OD	3	94.7	31.6	1.51	0.2
FD	3	118.8	39.6	1.89	NS
FOD	3	26.9	8.98	0.43	NS
DS:OF	96	2008.3	20.9		
T	19	70.9	3.73	3.3	<.0001
OT	19	22.5	1.18	1.05	NS
FT	19	11.6	0.609	0.538	NS
FOT	19	15.1	0.796	0.704	NS
TS:OF	608	687.3	1.13		
DT	57	94.4	1.66	2.22	<.01
ODT	57	53.4	0.936	1.26	NS
FDT	57	65.1	1.14	1.53	.01
FODT	57	41.3	0.725	0.973	NS
DTS:OF	1824	1357.9	0.744		

FOURTH ANOVA

Source	DF	Sums of Squares	Mean Square	F-Ratio	Significance
Between Ss					
O	1	62.1	62.1	2.78	0.1
F	1	0.79	0.79	0.035	NS
OF	1	1.65	1.65	0.074	NS
S:OF	32	713.9	22.3		
Within Ss					
D	3	16.2	5.39	1.34	0.26
OD	3	9.38	3.13	0.778	NS
FD	3	10.3	3.43	0.854	NS
FOD	3	21.0	7.0	1.74	0.16
DS:OF	96	386.1	4.02		
T	19	12.24	0.644	5.545	<0.0001
OT	19	1.06	0.056	0.483	NS
FT	19	2.4	0.127	1.091	NS
FOT	19	4.21	0.222	1.909	0.01
TS:OF	608	70.63	0.116		
DT	57	4.98	0.087	0.845	NS
ODT	57	5.03	0.088	0.852	NS
FDT	57	4.32	0.076	0.732	NS
FODT	57	6.01	0.106	1.018	NS
DTS:OF	1824	188.98	0.1036		

FIFTH ANOVA

Source	DF	Sums of Squares	Mean Square	F-Ratio	Significance
Between Ss					
F	1	98.61	98.61	0.743	NS
S:F	44	5842.77	132.79		
Within Ss					
D	3	213.58	71.19	2.893	.0378
FD	3	113.79	37.77	1.535	.208
DS:F	132	3243.59	24.61		
T	9	56.32	6.258	3.419	.0004
FT	9	34.72	3.858	2.108	.028
TS:F	396	724.91	1.831		
DT	27	64.62	2.393	2.356	.0001
FDT	27	60.34	2.235	2.199	.0004
DTS:F	1320	1341.21	1.016		
Within Cells					
R:FSDT	1840	960.73	0.522		
Total	3679				

SIXTH ANOVA

Source	DF	Sums of Squares	Mean Square	F-Ratio	Significance
Between Ss					
F	1	116.06	166.06	1.638	0.207
S:F	44	4451.71	101.38		
Within Ss					
D	2	121.58	60.79	2.384	NS
FD	2	39.82	19.91	0.781	NS
DS:F	88	2243.98	25.5		
T	19	45.90	2.415	2.708	0.0001
FT	19	32.41	1.691	1.9122	0.0107
TS:F	836	745.79	0.892		
DT	38	44.33	1.166	1.888	0.001
FDT	38	54.67	1.439	2.329	0.00001
DTS:F	1672	1032.76	0.6177		

APPENDIX 5: MORPHINE MEDICATION

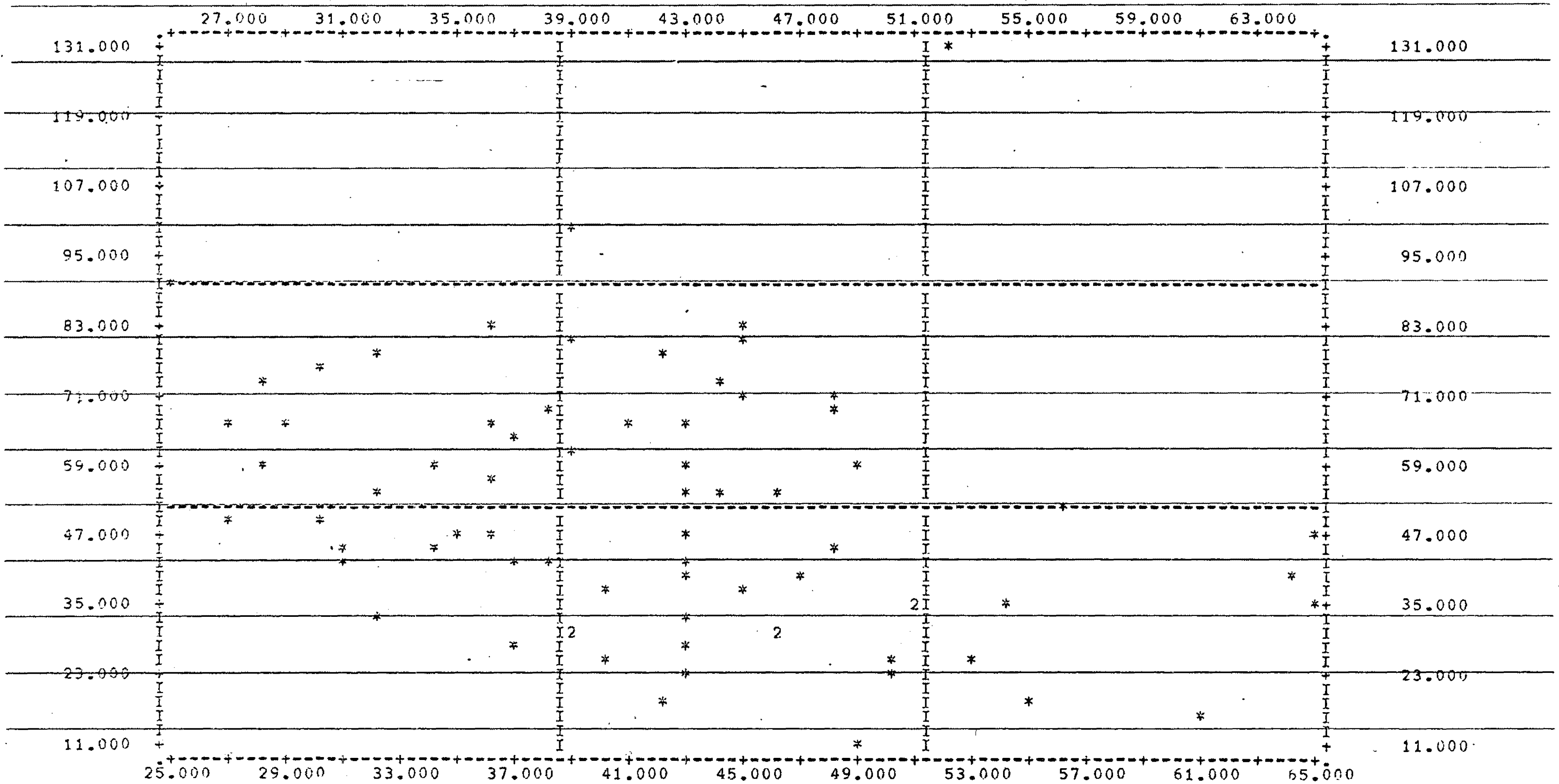
MORPHINE MEDICATION

A variety of combinations of medications was used in this study. The following distribution shows the patterns of administration of opioid drugs over 3 days for 71 Ss. (data missing for 2 subjects) Simple analgesics were given as well.

Day 1	Day 2	Day 3	N. of Ss
Pethidine	Pethidine	–	3
Pethidine	Ciramodol/Omnopon	–	1
Pethidine	Omnopon	–	3
Pethidine	Pethidine	Pethidine	1
Omnopon	–	–	11
Omnopon	Omnopon	–	20
Omnopon	Omnopon	Omnopon	3
Omnopon	Ciramodol/Omnopon	–	17
Omnopon	Ciramodol/Omnopon	Morphine	1
Buprenorphine	Omnopon	–	1
Ciramodol/Omnopon	–	–	2
Ciramodol/Omnopon	Omnopon	–	8

APPENDIX 6: SCATTERGRAMS

SCATTERGRAM OF (DOWN) UTW TOTAL MORPHINE PER 70KG (ACROSS) A AGE
SUBFILES PROCESSED: ALL

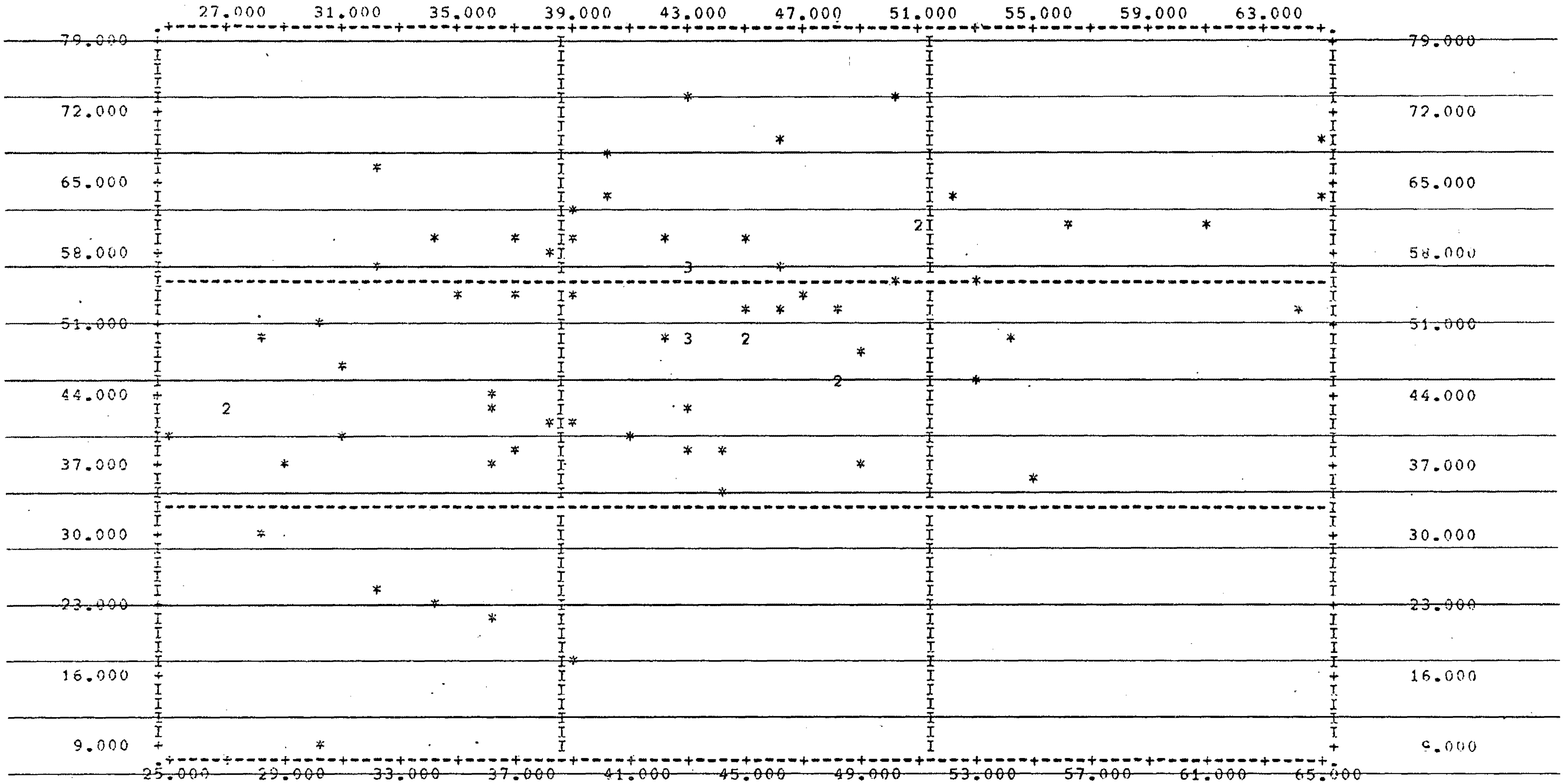


FURTHER SCATTERGRAMS FROM COMB.SPD I.E.ALL SS 10-NOV-81 PAGE 8
FILE: COMB.SPD COMBINED DATA FROM EXPTL AND CONTROL GROUPS

STATISTICS..

CORRELATION (R)-	-0.30518	R SQUARED -	0.09314	SIGNIFICANCE -	0.00914
PLOTTED VALUES -	72	EXCLUDED VALUES-	0	MISSING VALUES -	1

SCATTERGRAM OF (DOWN) P PILOWSKY (ACROSS) A AGE
SUBFILES PROCESSED: ALL



FURTHER SCATTERGRAMS FROM COMB.SPD I.E.ALL SS 10-NOV-81 PAGE 10
FILE: COMB.SPD COMBINED DATA FROM EXPTL AND CONTROL GROUPS

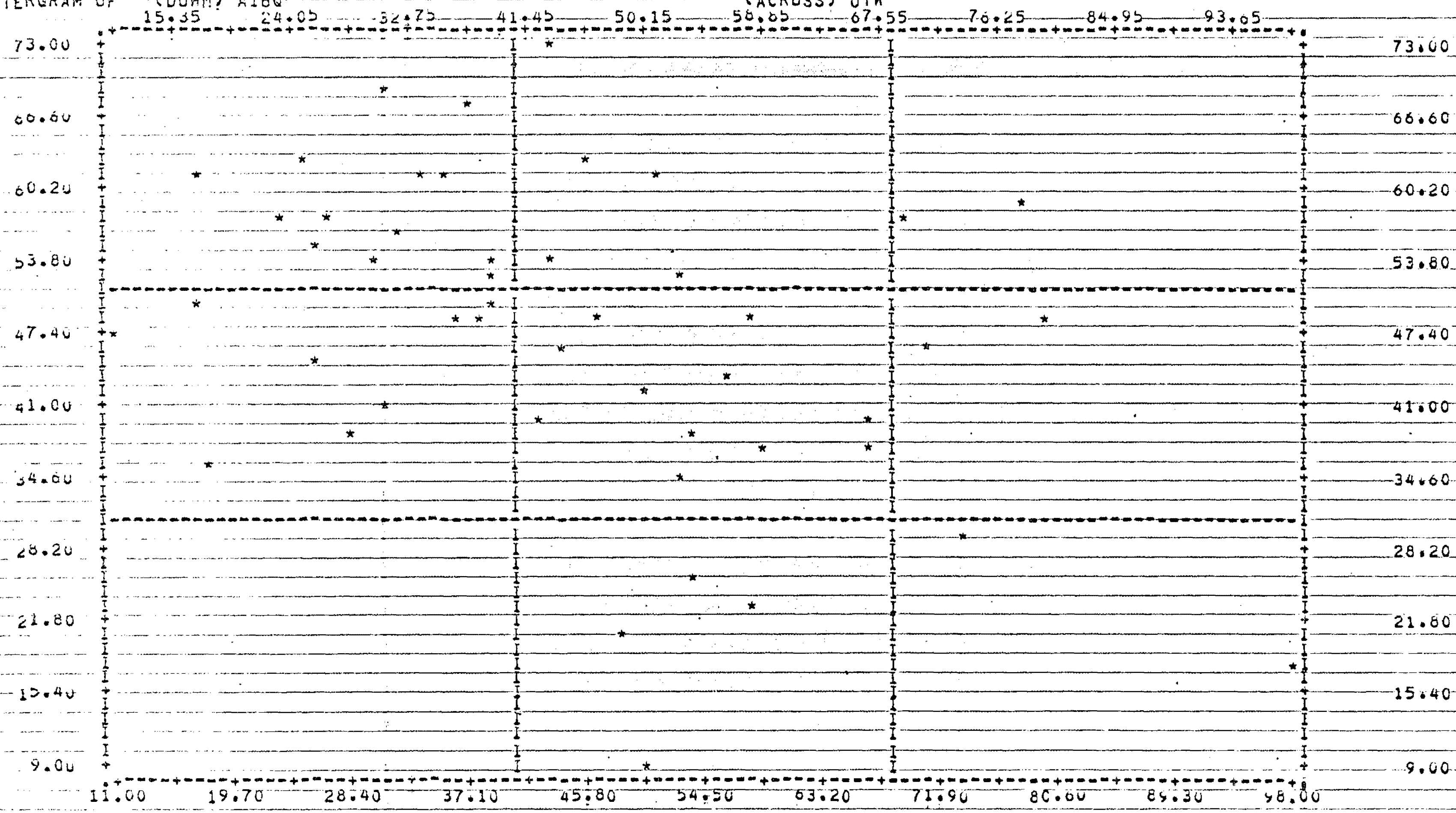
STATISTICS..

CORRELATION (R)-	0.41096	R SQUARED -	0.16889	SIGNIFICANCE -	0.00030
PLOTTED VALUES -	73	EXCLUDED VALUES-	0	MISSING VALUES -	0

EMG AND MORPHINE,PAIN,ETC. 09/26/81 PAGE 12

FILE NONAME (CREATION DATE = 09/26/81)

SCATTERGRAM OF (DOWN) AIBQ (ACROSS) UTW



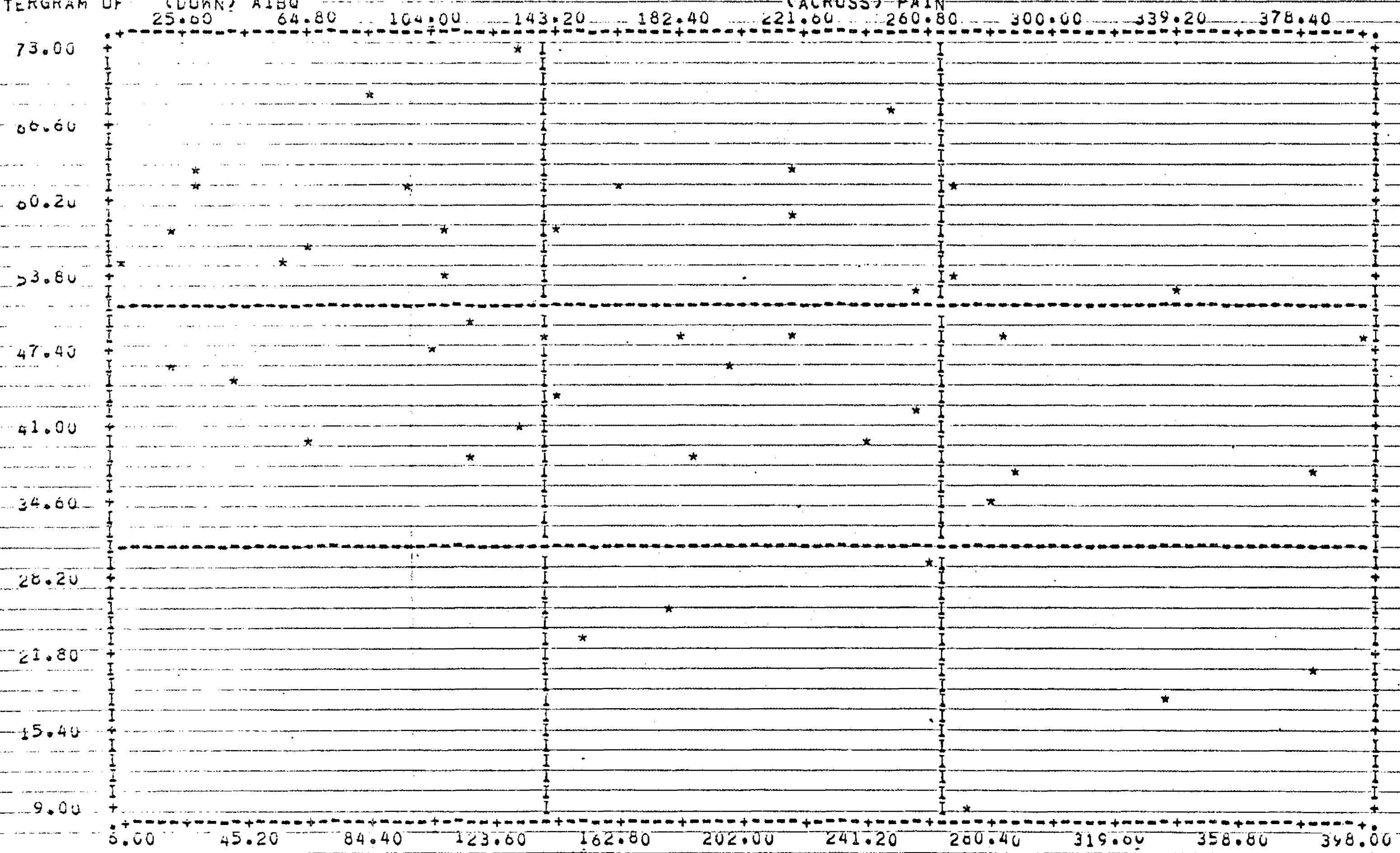
EMG AND MORPHINE,PAIN,ETC. 09/26/81 PAGE 13

STATISTICS..

CORRELATION (R)-	-0.38931	R SQUARED -	0.15156	SIGNIFICANCE -	0.00312
STD ERR OF EST -	12.78126	INTERCEPT (A) -	60.24928	SLOPE (B) -	-0.28762
PLOTTED VALUES -	48	EXCLUDED VALUES-	0	MISSING VALUES -	1

EKG AND MORPHINE,PAIN,ETC. 09/26/81 PAGE 10

FILE NONAME (CREATION DATE = 09/26/81)
SCATTERGRAM OF (DOWN) AIBQ (ACROSS) PAIN

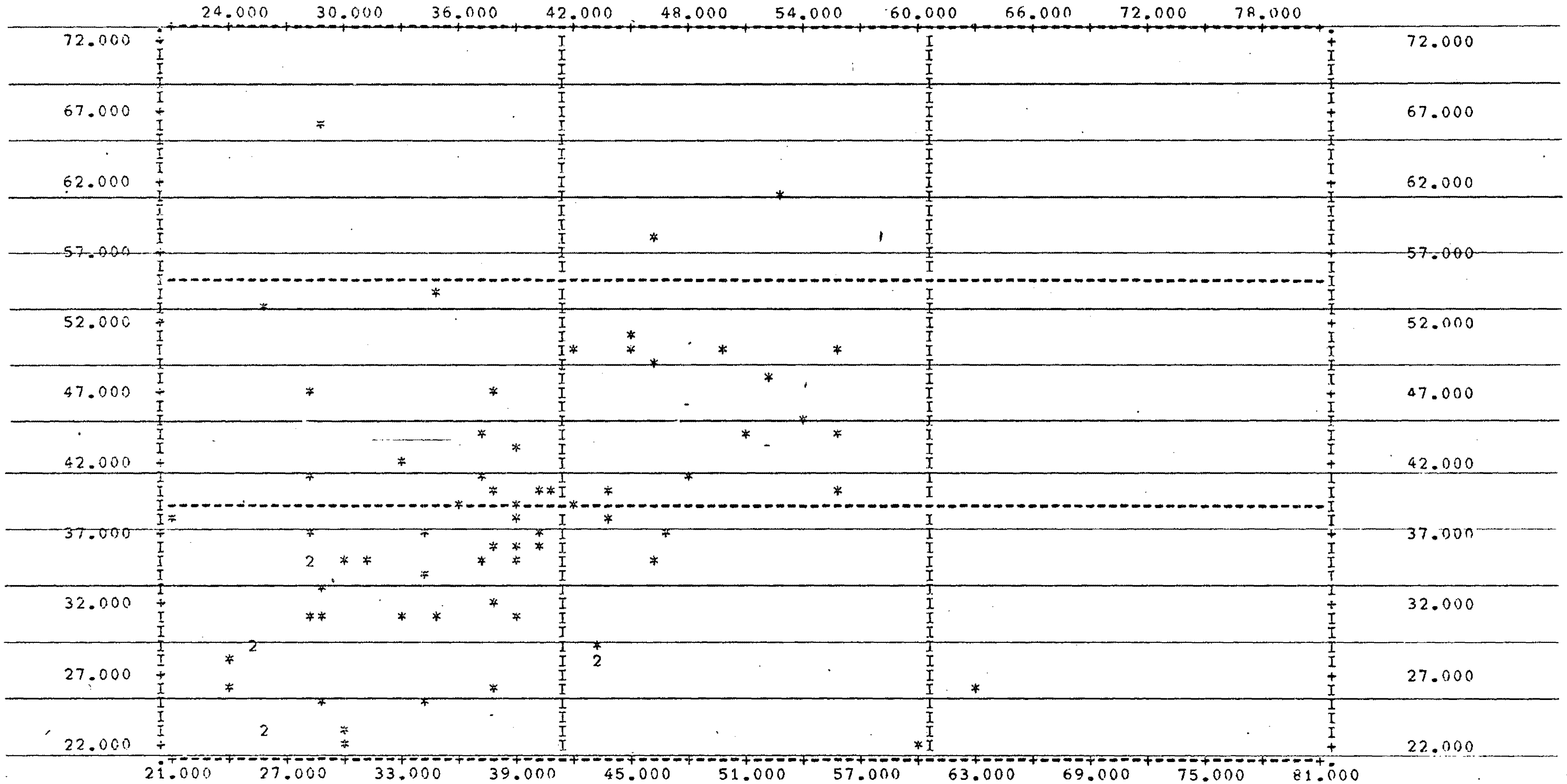


STATISTICS..

CORRELATION (R)-	-0.40503	R SQUARED -	0.16405	SIGNIFICANCE -	0.00262
STD ERR OF EST -	12.88112	INTERCEPT (A) -	57.11587	SLOPE (B) -	-0.05334
PLOTTED VALUES -	46	EXCLUDED VALUES-	0	MISSING VALUES -	3

'********' IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

SCATTERGRAM OF (DOWN) X0 STATE ANXIETY PRE-OP (ACROSS) X2 TRAIT ANXIETY
SUBFILES PROCESSED: ALL



FURTHER SCATTERGRAMS FROM COMB.SPD I.E.ALL SS 10-NOV-81 PAGE 4
FILE: COMB.SPD COMBINED DATA FROM EXPTL AND CONTROL GROUPS

STATISTICS..

CORRELATION (R)-	0.29756	R SQUARED -	0.08854	SIGNIFICANCE -	0.01113
PLOTTED VALUES -	72	EXCLUDED VALUES-	0	MISSING VALUES -	1

APPENDIX 7: PATIENTS' COMMENTS ON STUDY

PATIENTS' COMMENTS

Only two subjects commented negatively, "not really any use", and "rather tiresome". Others contributed some constructive remarks.

"To relax is beneficial but, of course, a busy wife and mother never has time."

"The highlight of the day - would recommend it to anyone."

"I had used similar (relaxation) techniques in childbirth recently; I am sure the tremendously high quality of the nursing minimised the discomfort experienced after the operation."

"Would do it again if in hospital."

"A good idea - made me realise the need of relaxation when I go home."

"I think it was a good, sound idea; thoroughly enjoyed doing it."

"Talking to other patients I feel relaxation classes before an operation would be beneficial. I felt pleased with the reassurance given by all I came into contact with at the hospital. It was a pleasant interlude which I enjoyed."

"How about setting up a questionnaire for what patients want to know about their condition, treatment after discharge? This is equally worrying to the patient."

"This made a big improvement to me."

"It has made me feel involved even if I did not always feel like doing it because of nausea or pain."

"Have looked forward to the enforced relaxation, but difficult when pain is at a maximum."

"Has done myself a lot of good."

"I feel very confident in this trial, it makes you feel at ease."

APPENDIX 8: NOISE IN DECIBELS

NOISE IN DECIBELS

Noise was distracting, both from outside the hospital and from within the ward itself. Measurements, in decibels, were taken of noise levels on the final day of the study while taking EMG measures of 3 patients. Readings were taken every minute.

	Subject 1	Subject 2	Subject 3
	45	46	42
	44	38	38
	43	44	39
	43	41	37
	45	38	38
	46	52	48
	46	40	45
	46	41	46
	45	46	45
	42	42	42
	45	41	38
	51	39	44
	59	39	47
	52	39	40
	40	46	41
	51	41	40
	43	40	40
	42	39	51
	44	42	39
	51	39	42
		44	46
Mean	46.15	41.76	42.23
SD	4.5	3.5	3.9